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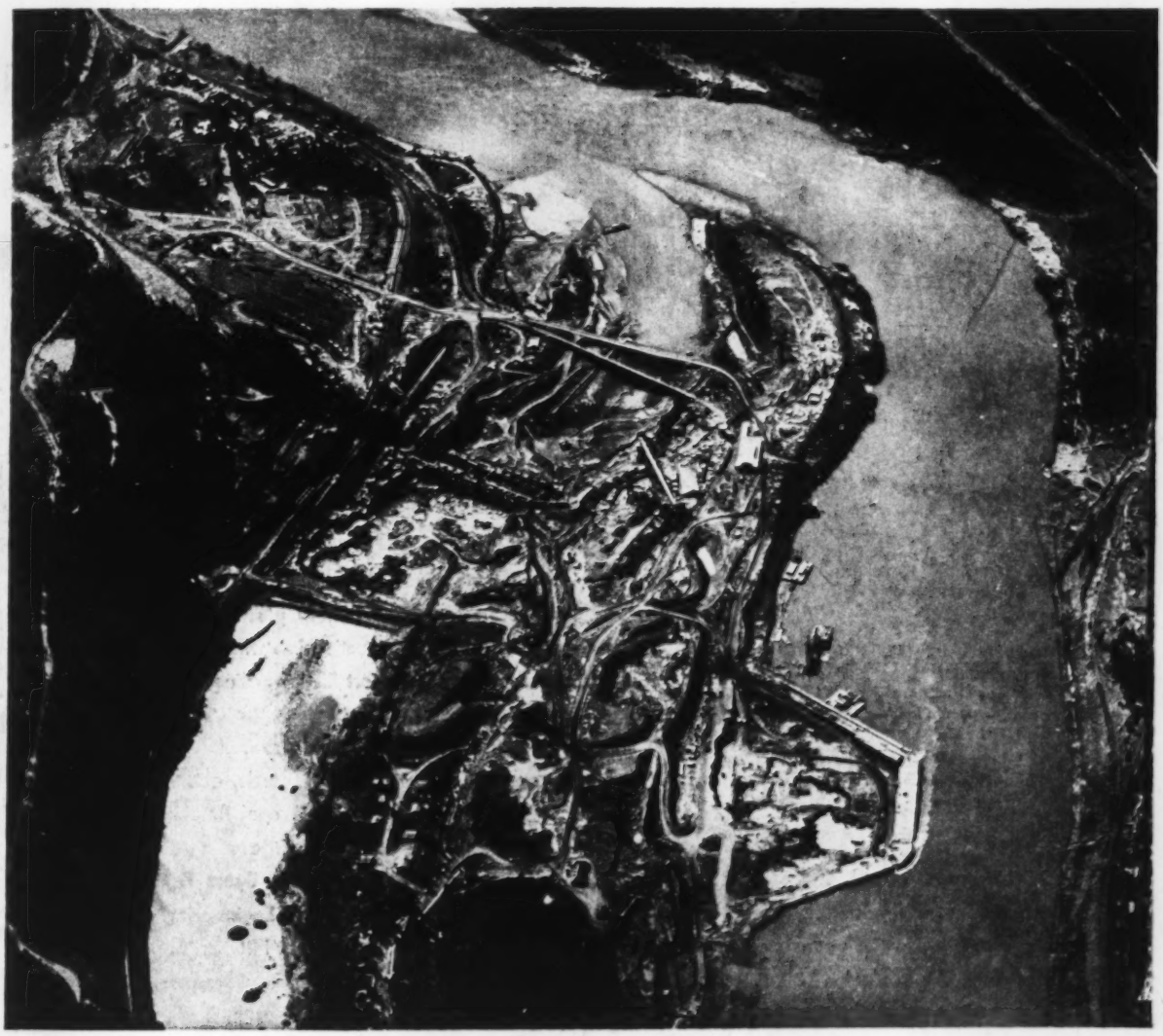
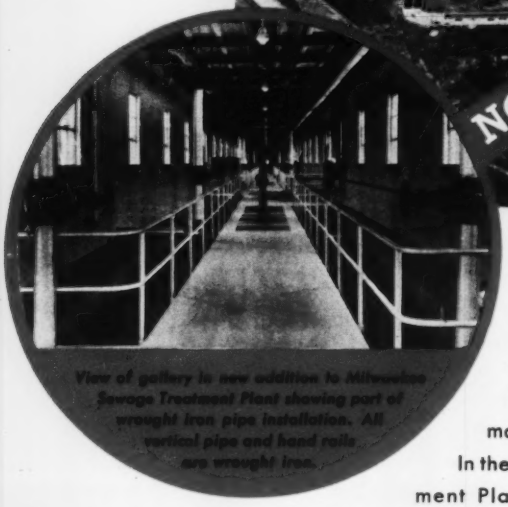


DAMMING THE COLUMBIA AT BONNEVILLE is up to schedule in spite of recent high water. From Oregon to Washington (left to right) ship locks, power house, concrete mixing plant and main cofferdam, closing off about half the river channel, present scenes of widely varied activity

WROUGHT IRON..

FOR SEWAGE TREATMENT

Corrosion



View of gallery in new addition to Milwaukee Sewage Treatment Plant showing part of wrought iron pipe installation. All vertical pipe and hand rails are wrought iron.

SEWAGE treatment conditions are unusually severe. Hydrogen sulphide, oxygen and salts in solution are always present. That's why leading engineers, anxious to select the best materials, specify wrought iron. Facts, not claims, back up this choice. Wrought iron has demonstrated its long life and economy in sewage treatment service in many leading municipalities.

In the Milwaukee Sewage Treatment Plant, illustrated, wrought iron's record dates from 1925, when the plant was first put in operation. Having proved its worth in sub-airheaders, downspouts, heating returns and hand rails, wrought iron was again specified for these services in the new addition recently completed.

If you are planning a sewage treatment plant or any other construction job where corrosion makes short life of ordinary pipe, plates, or sheets, we suggest you consider Byers Wrought Iron. Engineering data, service records, estimating prices, suggested specifications and other information are readily available through any Byers Engineer or by writing our Engineering Service Department at Pittsburgh.

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A Road to Self-Help

TWO weeks ago this journal commented editorially on a development that, although quite apart from the work-relief situation, has a bearing on it. Under the caption "A Bigger Crowbar" the editors cited the opportunities offered by the extension of the National Housing Act to cover loans for industrial modernization.

Although $50,000 per project is not much, this move can be made helpful. The original act authorized federal insurance on home modernization loans up to $2,000. Under it a substantial volume of business has developed for architects and builders and for producers of materials and appliances. Now, with a $50,000 limit, applicable to commercial and industrial buildings and plant, more business should be available for engineers as well as architects, for heavy contractors as well as house builders and for the producers of engineering equipment and materials as well as those who serve the small house market. Moreover, such an increase in low-cost betterments may well stimulate larger projects, to be undertaken without benefit of the FHA. Already the volume of private construction is rising rapidly as compared with that of last year.

NEEDLESS to say, the business developed under the $2,000 home-loan provisions of the act was not dumped into the laps of the beneficiaries. Architects hustled for it, builders hustled for it and, more than all the rest, the producers of materials and appliances hustled for it. Many a building worker has had a job during the last year because aggressive members of those three groups organized and labored to make the act productive.

All of which reminds us that, except for the producers, the construction industry generally is lacking in that merchandising faculty which creates understanding and appreciation of the value of a service and thereby transmutes opportunity into business. Too many architects, engineers and contractors wait for business to seek them out rather than create it. When some one decides to build a new building, extend his plant or modernize his home, they say, he will call in an architect or engineer and ask contractors for bids. But why wait? If the architect and engineer are trained to plan for greater economy and efficiency why should they not acquaint owners, inexpert in such matters, with the values they offer? If a contractor knows that he can make a structure more valuable to its owner why should he not go to him and tell him so?

Two current conditions lend point to these queries. One is the effect of the depression in paralyzing the initiative of investment capital and industrial management. For their own good, these must be stirred into action; who is more logically cast for the rôle than those whose expert services can be of real value?

MOREOVER, the FHA sets the stage for such action. It offers insurance to lending institutions on approved loans. Here action by the lender will depend largely on his belief in the wisdom of the improvements to be effected; as the loan must be amortized within a reasonable period, this is of first importance. So the bank will be influenced by the assurance of a competent and practical technical advisor; the owner will be spurred by the prospect of a loan for an improvement that soon will pay for itself; the architect, engineer or contractor thus creates a job for himself while he renders a very real public service.

But what has this to do with the public works situation? Simply this: one reason why many are so disturbed by a perversion of the public works program is their utter dependence on it for business. If there is no public work, they ask, how can they live? But construction was not always so utterly dependent on public works. And if it is to come back, as it surely will, it cannot remain utterly dependent on them. Sooner or later it will again be employed chiefly on private construction; the more it can speed that day the sooner will it be reestablished on a healthy basis.

So, while we are fighting abuse of the work-relief appropriation, let us spare thought for these questions: should not the members of the construction industry, including its architects, engineers and contractors, learn how to sell their services more aggressively to those who need them? Does not the FHA program offer them an unusual opportunity to do that just when they most need it and can best justify it?

All this deserves the serious thought of those who are unwilling to "wait until things come back" and who would find a way to help themselves.

Willard Chevalier

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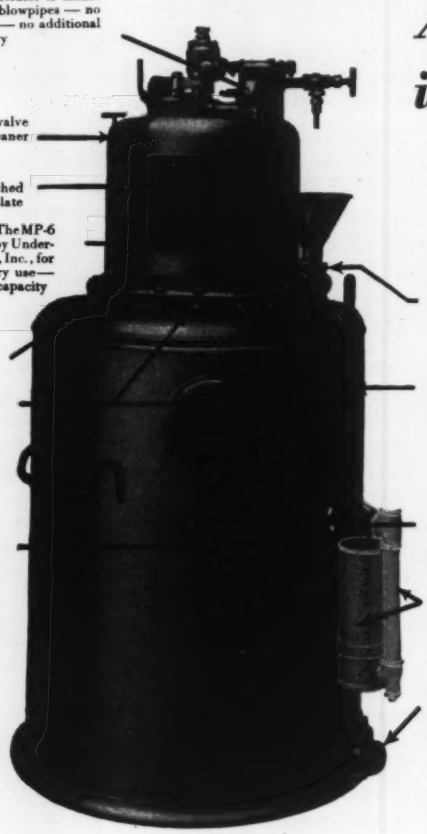
THE NEW OXWELD MP-6

Another Great Advance in Acetylene Generators


Pressure is adjustable up to 14 lb. per sq. in. This generator is usable with all types of blowpipes — no pressure fluctuation — no additional regulator is necessary
Wrench for built-in valve cleaner
Instructions on attached metal plate
Underwriters' Label. The MP-6 is listed as standard by Underwriters' Laboratories, Inc., for portable or stationary use — 100 cu. ft. per hour capacity
Residue agitator handle
Hand hole and hinged top render mechanism easily accessible
Small, compact and sturdy, it has a minimum of external piping and accessories. It is simple to operate and maintain, and has no complex carbide feed devices
Water filling valve is of lubricated plug type
Interference levers are simple, but positive
Overflow valve is of the lubricated plug type
For stationary service, vent trap and overflow assembly is included
Residue valve is of the lubricated plug type

SPECIFICATIONS—OXWELD TYPE MP-6
MEDIUM PRESSURE ACETYLENE GENERATOR

Carbide Capacity (1/4 x 1/12 in. size)	50 lb.
Water Capacity	50 gal.
Generating Capacity per hour	100 cu. ft.
Weight — Empty	415 lb.
Weight — Charged with water and carbide	890 lb.
Weight — Shipping	580 lb.
Height — Overall	62 in.
Length, front to back	36 in.
Diameter — Water Shell	29½ in.

THE new 50-lb. Oxweld Type MP-6 Medium Pressure Acetylene Generator embodies the latest features of generator design and construction. Many of these features were never before included in any but the larger sizes of Oxweld Generators. Study the unusual things about the MP-6 illustrated above. Notice how well it is built for maximum efficiency in handling and use.

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In the News:

THE PRESIDENT has allocated $50,000,000 of the four-billion-dollar relief fund to aid the youths of the country in completing their education or in finding employment. Jobs to train 150,000 youths are to be created. What kind of jobs is not stated. For young engineers many openings could be created by the long-advocated expansion of Coast and Geological Survey operations.

THE SIXTH LIMITED-DIVIDEND HOUSING PROJECT to be built under the PWA low-rent housing scheme has opened its doors. It is the Neighborhood Gardens housing development in St. Louis, five buildings of 641 rooms, built at a cost of $640,000.

MORE THAN HALF THE $108,800,000 that will be required to complete Boulder Dam and its power houses will go for the purchase of materials, the purchase of which provides labor in other communities, according to Elwood Mead, head of the Reclamation Bureau. In the four years that the work has been in progress the bureau alone has spent nearly $24,000,000 on cement, steel, construction equipment and other materials.

REPRESENTATIVES of 25 states met at Spring Lake, N. J., June 28-29 to consider the establishment of uniform standards covering minimum wages, hours and labor conditions. The effort is directed toward doing, by interstate compact, what the Supreme Court said could not be done by federal law.

NEARLY $2,000,000 has been deposited with the U. S. District Court in Chicago by the PWA to pay for land in the $7,000,000 South Park Gardens project. More than half the land is now under option; the remainder will be condemned.

In This Issue:

THE LACK OF EXPANSION JOINTS in the 1,820-ft. concrete municipal recreation pier at St. Petersburg, Fla., was one of the principal causes for serious deterioration of the concrete beams, girders and slabs. Considerable stress due to temperature variations led to a spalling of the concrete below the reinforcing steel, and seepage of water from a depressed section carrying streetcar tracks assisted in further destruction. The procedure for repair required a good deal of ingenuity and patience.

TECHWOOD, IN ATLANTA, GA., is the first project to be placed under construction in the all-federal low-rent housing program. Serving as an experimental unit for the planning of 40 more projects that are to follow, this 22-building development, covering 25 acres of ground, will be watched with great interest.

THEORETICAL CONSIDERATIONS, practical application and recommended construction procedure relating to the use of salt as an element in soil mixtures for road construction are presented as a summary of the latest developments. Although this type of road has been in use for only a short time, it holds promise of development.

THE COMBINED FORCES exerted by a 60-ft. head of water and saturated volcanic sand brought about external pressures that were barely sustained with a single line of sheetpiles forming a cofferdam on the Cowlitz River in Washington. The bracing consisted of a rectangular cage of timber that was sunk as the excavation proceeded downward.

CONSTRUCTION PROGRESS on the Bonneville project in Portland, Ore., is about six months ahead of schedule, and protection efforts are under way to provide for an estimated floodwater flow of 700,000 sec.-ft. this summer. Fishery interests will be safeguarded by an estimated outlay of $3,000,000 for the construction of fishways up the river and around the dam.

Coming Articles:

John F. Stevens served as chief engineer of the Panama Canal for two of the most difficult years of the early American operations. After nearly 30 years he writes of those stirring days, telling, in three articles, of his part in the controversy over the type of canal to be adopted and of the little-known work of the civilian engineers in the period before the project was turned over to Col. George W. Goethals as Mr. Stevens' successor.

Huge steel cylinders up to 8½ ft. in diameter and 69 ft. long bore their way to rock to form foundation caissons for the new federal building in New York. This new method in foundation construction and the machine which supplies the rotating power will be described in an article to be published next week.

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When you buy these cements to build a road, or a dam, or a bridge, or a building, you know that you can't buy a better product, because Atlas and Universal portland cements fully meet the standards set by both the federal government and the American Society for Testing Materials.

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So we simply say this—when you have a particular concrete problem on which you want accurate and current information, we'll be glad to hear from you. We think that this cooperation is part of our job—and while it doesn't go through those kilns, we make it an ingredient of every barrel of Atlas and Universal cement that goes to make good concrete. Try us out!

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ENGINEERING NEWS-RECORD

July 4, 1935

Concrete Repairs on an Ocean Pier

Deterioration of long Florida pier checked with aid of waterproofing, new expansion joints and ingenious patching

By Frank G. Lee
and Paul Jorgensen
City Engineer and Structural Engineer St. Petersburg, Fla.

FIG. 1—RECREATION PIER at St. Petersburg, Fla., whose 1,820-ft. concrete deck is being extensively rebuilt and repaired to check destructive deterioration.

A LONG ocean pier which was approaching an unsafe condition through expansion, leakage of ponded water and scaling that had badly damaged the concrete, has recently been made sound by interesting repairs and reconstruction at St. Petersburg, Fla. Two sets of operations were required, one being reconstruction to provide waterproofing and means for expansion movement and one an extensive patching job where the original concrete had scaled and exposed the reinforcement. Like all such operations much fussy detail procedure was required, and, particularly in expansion joint construction, some ingenuity. Description, therefore, is very largely a recitation of details, and these are presented by illustration.

Pier structure

The Municipal Recreation Pier at St. Petersburg, Fla., is a reinforced-concrete structure, extending 1,820 ft. into the waters of Tampa Bay. The pier consists of an approach 1,400 ft. long and 100 ft. wide, carrying a 72-ft. roadway and two 14-ft. sidewalks leading to a pierhead proper, 420 ft. long and 300 ft. wide. A streetcar track in the center of the roadway extends the entire length of the approach to a terminal at the two-story casino building on the pierhead. The pier was built from October, 1925, to December, 1926, and represents a total investment of $998,700. It serves as a recreational center throughout the entire year and is considered one of the major assets of the community.

The airplane view (Fig. 1) and the isometric cross-section of a typical approach span (Fig. 2) give a very clear idea of the construction. The approach consists of 70 spans of 20 ft. supported by pile bents, each of 11 precast concrete piles. The piles, 16x16 in. in section, vary in length from 30 ft. at the

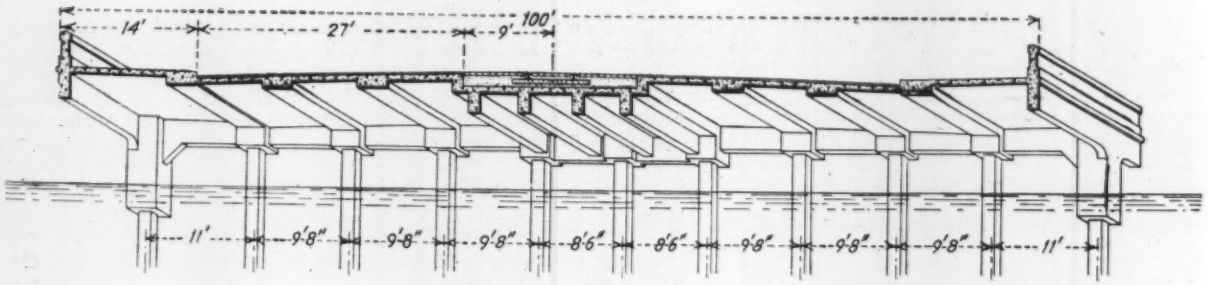


FIG. 2—ISOMETRIC SECTION of St. Petersburg pier, showing typical deck construction.

inshore end to 60 ft. at the pierhead, the total number being 1,675. The depth of water varies from zero at the abutment to about 17 ft. at the outer end of the pierhead. The deck of the approach is of typical slab and beam construction, with wide shallow beams supporting the roadway slab and deeper beams under the depressed area supporting the streetcar track. It is to be noted that the roadway beams frame directly into caps on each pile, while the beams supporting the streetcar track frame into a cross-girder supported on three piles.

The part of the pierhead directly under the casino building is of flat-slab construction of the paneled-ceiling type of 20-ft. spans. Each support consists of four precast piles framing into one common cap 7x7 ft. in plan. The portion of the pierhead outside the casino is of similar construction to the approach spans.

Evidences of deterioration

Serious deterioration of the concrete beams, girders and slabs of the pier was discovered in the summer of 1932. This deterioration had progressed so far that it was recognized that the repairs and reconstruction necessary to preserve the safety of the structure would be a major operation and entail a considerable expenditure. It was also evident that unless repairs were made within a comparatively short time the deterioration would progress even more rapidly, and the pier would soon become unsafe for public use. An exhaustive and detailed examination was made to determine the nature and extent of the damage that had occurred. A thorough study of the causes of the deterioration was also made to develop a method for repair and reconstruction that would prevent further progress of such action. The structure was kept under constant observation until late in the summer of 1933, when funds were made available to proceed with the work.

It was noted that there was practically no deterioration in the precast concrete piles. The most notable evidence of damage was the spalling of the concrete below the plane of the reinforcing steel and the progressive corrosion of the steel. This condition is plainly shown by Figs. 3 and 4. A proportionately greater number of the deep beams carrying the streetcar track was affected than of the shallow beams supporting the roadway slab. It was also noted that the greatest concentration of damage occurred in the first ten bays of the pier next to the inshore end of the approach.

All of the construction joints, which extended transversely across the structure in the center of each span, were open. In addition, there were a large number of transverse cracks that had appeared in the deck near the inshore end. The sidewalk slab, especially, was badly cracked near the construction joints. These joints seemed to form a focal point for the start of deterioration which progressed in both directions. One very pertinent feature brought out by the examination was the constant seepage of water through the construction joints in the pocket under the streetcar track area.

Analysis of deterioration

Analysis led to the conclusion that the deterioration was due to one of several different causes or to a combination of such causes. The pier was constructed without expansion joints, and it seemed to be apparent that the lack of such expansion joints was largely responsible for the damage that had occurred to certain parts of the structure. A series of observations at the outshore end of the pierhead showed that there was comparatively little movement at that point, and consequently it was safe to assume that considerable stress due to temperature variation must have been set up in various parts of the superstructure.

Careful observation of the action of the construction joints in the center of each of the approach spans proved conclusively that these joints were operating to a certain extent as expansion

FIG. 3—BAYS NEAR ABUTMENT showing the advanced deterioration of this section, spalling, cracking and seepage of water through the deep beams.

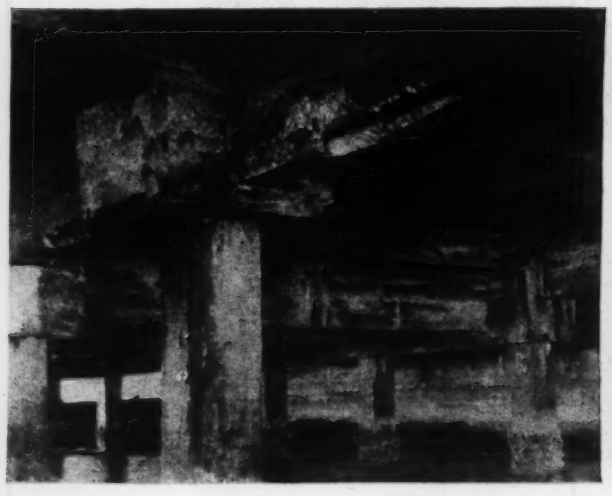


FIG. 4—ROADWAY BEAM, showing reinforcing badly corroded and exposed due to spalling of concrete. Cracks in pile and cross-strut are visible.

joints inasmuch as they opened and closed under changing temperatures. A number of these joints opened as much as ⅛ in. This "working" of the construction joint broke the bond on the reinforcing steel near these points with consequent spalling of the concrete below the plane of reinforcement. The seepage of water through these openings and the corrosion of the reinforcement naturally greatly intensified the damage there.

Another contributory factor of major importance was the entire lack of drainage and waterproofing in the depressed section carrying the streetcar track. This pocket acted as a reservoir to collect such water as had filtered down through the pavement of that area and that slowly seeped through the construction joints until it reached the reinforcing steel in the supporting beams.

Aside from the damage caused by these two very important factors, numerous instances were noted in which the deterioration was due to that common fault in concrete construction exposed to sea water, i.e., insufficient covering of the reinforcing steel. This cause, combined in some instances with evidences of porous concrete, especially in the members of deeper section, explained a number of examples of serious damage that had occurred.

Repair and reconstruction

The work necessary to be done to remedy the conditions fell naturally into two classifications: first, the reconstruction necessary to remove the causes of deterioration; and, second, the repairs necessary to remedy the damage which had already occurred. It was accordingly decided that the logical method to be adopted must: (1) provide for the installation of the necessary expansion joints; (2) effectively waterproof and drain the area in the streetcar track pocket and effectively fill the construction joints and other cracks on top of the deck; and (3) by means of the Gunite method repair the defective members of the structure. It is intended eventually to provide a waterproofing coat of emulsified asphalt or other similar material over the entire undersurface of the pier to eliminate so far as possible further destructive action due to sea-water exposure.

Expansion Joints—It was evident that the most expensive and most hazardous operation would be the installation of the expansion joints, and considerable study was given to the question of their proper number and location. The first consideration, of course, was to locate the joints so that the number would be a minimum consistent with efficient action. It was obvious, also, that the introduction of expansion joints allowing free movement of the superstructure would induce stresses in the supporting piles. The amount of such movement and of the stresses in the piles is not susceptible to exact mathematical determination due to the various unknown factors entering into the case. A careful study, however, of all the factors involved resulted in a decision to locate the expansion joints at such position that the maximum movement of the pilehead would be ½ in. in either direction, allowing for a total variation of 2 in. at each joint. Analysis indicated that four expansion joints would be required to provide sufficiently for expansion. As the piles next to the inshore end had shorter unsupported lengths and were thus subject to greater stresses for a given deflection, it was decided to locate the first expansion joint 120 ft. from the abutment. The other three joints were spaced 420 ft. apart.

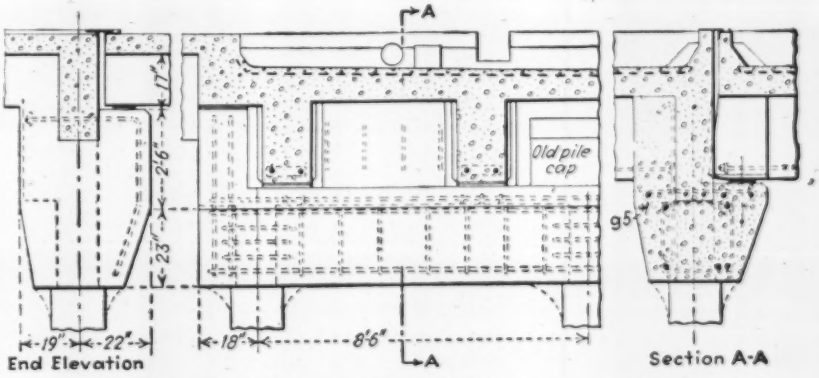


FIG. 5—DETAILS OF NEW CROSS-GIRDERS under track trough constructed to provide for expansion joints in deck of St. Petersburg pier.

It was at first feared that it would be necessary to drive an additional bent of piles at each of the expansion joints, entailing the reconstruction of an entire span at these locations and making it necessary to discontinue traffic while this work was being done. A number of trial designs were made, and a method was finally developed, however, by which additional girders and brackets could be constructed upon the existing pile bents and the load transferred without either driving additional piles or interfering materially with the superstructure itself. This method undoubtedly saved a considerable expense and trouble that would have otherwise been necessary, and allowed the continuous use of the structure, except for streetcar service, throughout the entire period of the work.

The design of the expansion joint provided for an entire new cross-girder immediately below the old member supporting the streetcar beams, as shown by Fig. 5. In the design of this girder it was necessary to consider not only stresses due to bending moment and shear but such torsion as might be caused by the eccentric loading.

The first step in construction was to chip the piles to allow effective connection with the new member. Holes were then chipped through the original girder above the plane of the reinforcement to allow placing the reinforcing bars g-5 (Fig. 5, Sect. A-A), which were necessary effectively to reinforce the new member at the point of the application of the load. The remainder of the steel was then fastened into position, and forms were suspended by rods projecting through the top of the deck. These new girders were the only parts in the whole operation that were of poured concrete; the concrete was placed from above through holes cut in the slab. Because of the extremely cramped working space, very great care was taken to insure proper tamping and spading of the concrete, since it was especially necessary to secure a very dense concrete, as this member is at times submerged in the salt water. For additional protection, a protective coating consisting of 1 in. of Gunite was applied immediately after the forms were stripped.

As the introduction of the expansion joints increased the positive moments in the adjacent span, the beams framing into this point were strengthened by increasing their sections by Gunite applications and by additional reinforcement introduced and securely anchored (Fig. 5, Sect. A-A).

The design of the brackets supporting the roadway beams is shown in Fig. 5. The first step in the construction of the brackets was similar to that of the girders under the streetcar track—that is, the supporting pile was thoroughly chipped and cleaned immediately below the cap to allow for effective adhesion and the transmission of shearing stresses. The reinforcing steel was then placed in position and securely fastened, as shown by Fig. 6. The brackets were then built up by successive applications of Gunite. Usually it took from eight to ten applications to build up to the full section. Extreme care was used to prevent the formation of air and sand pockets in back of the reinforcing steel. The steel was thoroughly cleaned after each operation before the placing of the next coat of Gunite. After the bracket had been built out to the limits of the reinforcing steel, the wire mesh was placed and the finish coats were ap-

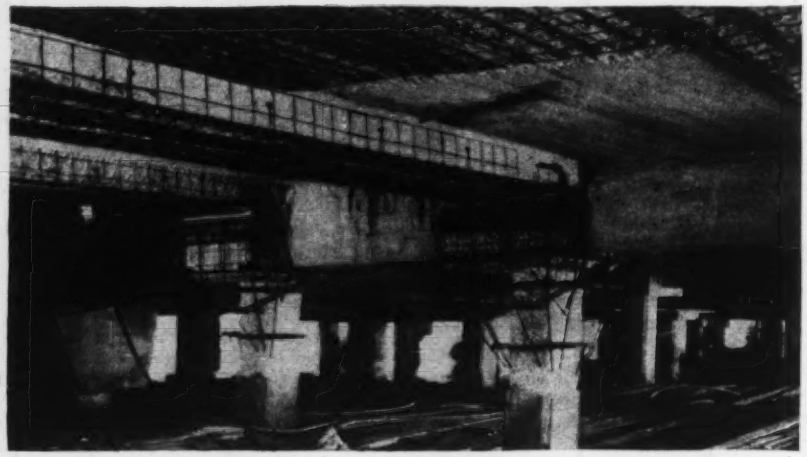


FIG. 6—EXPANSION JOINT under construction; new cross-girder is completed and carrying load; reinforcing steel and wire fabric are in place; two bearing plates are installed on left cap, and lower bearing plate is installed on right cap.

plied. After completion they were kept thoroughly moist for three weeks.

The outside girder supporting the sidewalk and railing required no additional reinforcement, as the original section was ample to take care of any additional stresses induced by the cutting of the expansion joints.

Inasmuch as the expansion plates were directly exposed to the attacks of sea water, considerable attention was given to the selection of a material that would be especially resistant to corrosion as well as meet the necessary requirements for a good bearing material. The alloy finally selected was a manganese bronze consisting of 56 per cent copper, 36 per cent zinc, 6 per cent manganese copper, 1 per cent tin and 1 per cent aluminum. The design of plates finally adopted is shown in Fig. 9. Special attention is called to the manner in which positive lubrication of these joints, under practical working conditions, was secured. The outer edges of the expansion plates on each side of the pier were provided with gage marks, so that a record could be kept of the expansion or contraction of each of the joints.

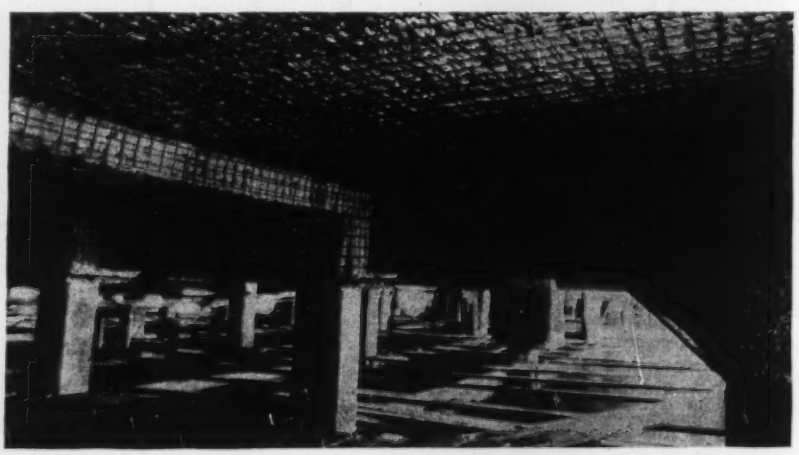
Recognizing the fact that the successful operation of the joints depended to a large extent upon the proper placement of the bearing plates, extreme care was used and a novel method developed to insure that the plates in their final location were absolutely level and plane. Fig. 9 shows this procedure clearly. A layer of rich grout was placed upon the top of the bracket or girder to the approximate grade and the plate was then placed upon it. Because the bearing plates were relatively flexible, a heavy steel plate in which were set four cap screws, was used to assure the proper placement of the lower bearing plate. By adjusting the cap screws against the under side of the beams above, it was possible to adjust the bearing plate to an exactly level plane. This steel plate was left in position for 24 hours. The steel plate was then removed and the bearing plates were checked very carefully for level in all directions. The upper bearing plate was then placed in position and carefully grouted into place. The arrangement used to secure the necessary density of the grout above the upper plate, insuring the proper transmission of the load, is also shown in Fig. 9. Timber stops were placed on each side of the expansion plates, and a tightening arrangement was used to secure thorough compression of the grout above the upper bearing plate.

To avoid excess movement in any one joint, it was decided to complete the supports for all joints and to proceed with the cutting of the deck at all joints at about the same time. The procedure adopted was to cut the slab and beams in the streetcar track pocket before any cutting was done on the roadway. The cutting was accomplished by pneumatic chipping hammers, special cutting tools being necessary for the deep beams from above and below. After the concrete was cut entirely away, the steel was cut loose by an oxy-acetylene torch, extreme care being used to avoid damage to adjacent concrete. After the beams and slabs had been cut through, the ends of the beams were rebuilt to secure at least 1-in. cover over the reinforcing steel that had been cut. After the slab and beams in the streetcar-track pocket had been cut, the roadway and sidewalk slabs were cut through at all joints. Arrangements were then made to cut the sidewalk and roadway beams loose as a continuous operation, working day and night to prevent any undue stresses upon the structure. The final step in the construction of the expansion joints was placing the sliding plates on the roadway deck. The method of fastening these plates is shown in Fig. 9.

The installation of the expansion joints was completed about the middle of December, 1934. An automatic recording device was installed at Joint No. 3 shortly after completion to obtain a continuous record of its action. It has been found that the movement corresponds very closely with that computed. The maximum observed contraction at each joint amounted to 1 in., occurring during a minimum atmospheric temperature of 28 deg. The maximum expansion was $\frac{7}{8}$ in., occurring under a temperature of 91 deg. The maximum change noted during a single 24-hour period was $\frac{5}{8}$ in. and was observed during a change of temperature of 18 deg. In no case has any evidence of distress in any of the new brackets or girders been observed at any joint or at any of the adjacent spans. Apparently the action of the expansion joints proceeded exactly as planned. The total observed maximum contraction, amounting to 4 in. for the four expansion joints, indicates very clearly the necessity for their installation and bears out the theory upon which their necessity was predicated.

The second step in the plan adopted to remove the causes of deterioration was to waterproof the streetcar-track pocket to eliminate further damage by

FIG. 7—SURFACE OF DEFECTIVE MEMBERS chipped and cleaned and covered with galvanized wire fabric ready for Gunite application.



seepage. To waterproof and drain the pocket, it was necessary to remove the paving, the track itself and all of the ballast for the entire length of the approach.

The original concrete surface was found to be extremely irregular, and it was necessary to resurface the entire area. The old concrete surface was thoroughly cleaned and chipped to provide for a minimum of ¾ in. of mortar, which was carefully placed to exact grade, as shown by Fig. 8. After this new layer was sufficiently cured and a 4-in. drain had been placed at the center of each span, the surface was given two priming coats of asphalt diluted with gasoline prior to placing the waterproofing membrane, consisting of two plies of 12-oz. saturated cotton fabric thoroughly mopped in with asphalt. Particular attention is called to the flashing into the sides of the pocket. The membrane was covered with a 1½-in. protective layer of concrete, reinforced with 6x6-in. wire mesh, screeded exactly to specified grade.

The original track section was composed of girder-type rails 7 in. high supported on 6x8-in. wood ties. The extra layers of concrete on top of the original surface reduced the effective depths of the streetcar-track pocket so that it was impossible to re-use the original track material. It was therefore necessary to determine the relative economy of replacing the rail section with a shallower type and re-using the original ties, or providing a tie section, which required a considerable less depth. It was decided to re-use the old 7-in. rail and replace the wooden ties with steel ties. These ties were dipped in hot asphalt before being placed. To provide for the free movement of the track section at the expansion joints in the pier structure, track expansion joints were provided. Crushed rock ballast was used.

A minor detail in the placement of the streetcar-track area was the location

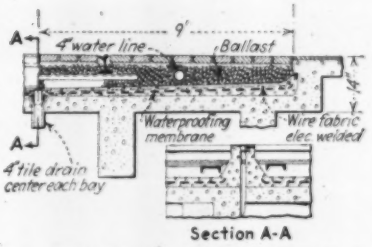


FIG. 8—WATERPROOFING of streetcar track trough of St. Petersburg pier.

of the water main supplying the pierhead. This main consisted of a 4-in. pipe provided with slip expansion joints at the joints in the pier.

Even during the early examination of the structure it was apparent that the Gunite process was the only practicable method of repairing the damage that had occurred. Due to the extreme exposure to salt water to which the structure was subjected, it was felt that repair operations would have to be carried on with the greatest of care to insure the success of the work. The procedure adopted was to chip out all defective sections of the concrete with pneumatic chipping hammers, chip and sandblast all the exposed reinforcement, place additional reinforcement in position wherever necessary and cover the entire surface with wire fabric before applying the Gunite coating. Fig. 9 gives a very good idea of this procedure. Particular attention was paid to the proper placing of the wire fabric, which was securely fastened in place by means of ⅜-in. lags and expansion shields. The entire surface was thoroughly cleaned and washed down prior to the application of Gunite.

The mixture used in the cement-gun operation was three parts sand to one part of cement. The gradation of sand was controlled as closely as possible,

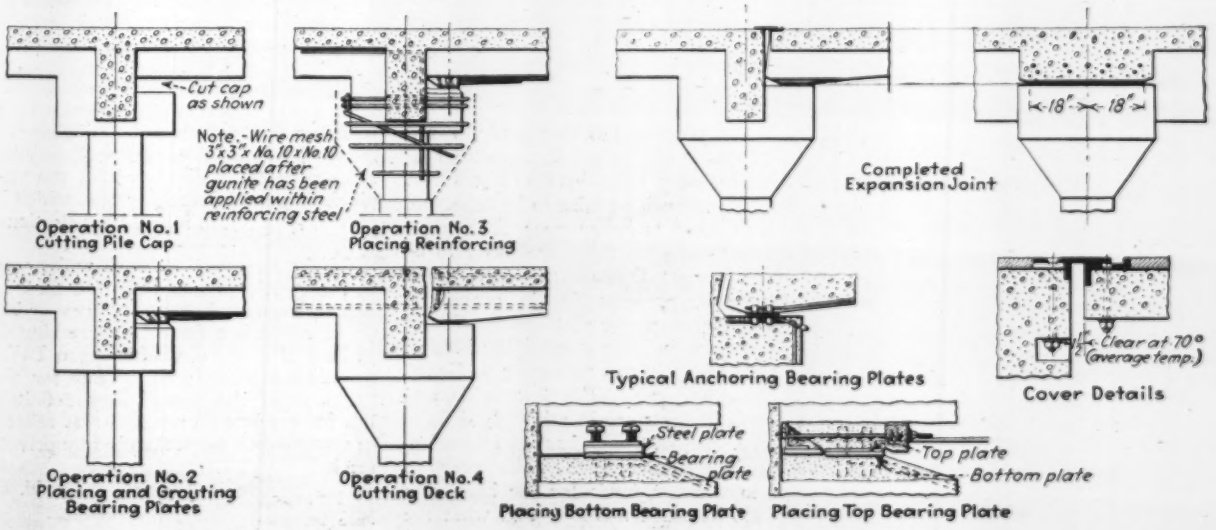
FIG. 7—EXPANSION-JOINT structure and construction under roadway deck of St. Petersburg pier.

considering the fact that a commercial grade had to be used. The water-cement ratio used was 4½ gal. per sack. The material was applied at nozzle velocity of 400 ft. per second. The coatings were usually applied in layers about ½ to 1 in. thick. An average total thickness of about 3 to 4 in. was required in order to incase the reinforcement thoroughly.

The equipment used in this work consisted of the standard cement gun, in connection with a 240-cu.ft. compressor and a concrete mixer of one-sack capacity. With this equipment it was possible to place 1½ cu.yd. of Gunite per hour of actual operation. A comparatively large proportion of the material was lost as rebound due to the fact that practically all the work was overhead. An estimate shows a rebound loss of about 25 per cent. Wherever appearance was a question to be considered, it was necessary to place "shooting strips" to secure the desired result. These strips necessitated some additional work due to the formation of sand pockets in their vicinity, but the results obtained were believed to justify the additional expense.

For all large areas that needed attention the work was carried out from staging underneath the structure supported by stringers resting on yokes fastened to the concrete piles (Fig. 9). For the smaller scattered areas that were affected, the work was carried on from barges. When working from the staging all equipment was placed on top of the deck, and the material hose carried through holes cut in the slab to the point of application. When operating from barges, the mixing plant (gun and mixer) and material was carried on a second barge alongside the pier with the compressor on top of the deck.

Extensive tests were carried on during the prosecution of the work to determine the adhesion of the Gunite to the original surface. All such tests gave excellent results. A number of 4-in. test cylinders, "shot" as the Gunite was



being placed, developed a strength as high as 7,000 lb. per sq.in. after 28 days. Extreme care was taken during the application of the Gunite coating to eliminate vibration from traffic and construction equipment. The Gunite operations are not as yet completed but are being carried on as fast as conditions will allow.

Consideration is now being given to the advisability of applying a special waterproofing compound to the entire under surface of the deck. Definite decision on this point has not yet been made.

It was, of course, necessary that positive steps be taken to insure the complete filling of the construction joints and contraction cracks that had occurred in the deck. This work was done during the coldest part of the season when the cracks and joints were open to their fullest extent. A chase, about 1 in. wide and extending almost through the slab, was chipped along each crack. Into this steel wedges were driven to prevent closing, and the chase was then thoroughly grouted. It was advisable to do this work in sections to avoid failure of the beams. The sidewalks required some additional work due to the fact that the top finish layer had flaked off along both sides of the cracks. At such locations all loose concrete was chipped away to a depth of about 2 in., the surface was covered with wire fabric anchored by lags and expansion shields and a new layer of mortar placed flush with the original surface.

Financing and expenditures

The city's budget for the fiscal year 1933 provided a sum of $6,000 to secure the necessary equipment and to make a start on the project. However, it was not until the initiation of the CWA program early in December, 1933, and the inclusion of this work in a preferred position in that program that funds were actually made available. Since that time the project has been carried on as a joint operation between the city of St. Petersburg, the CWA and later the FERA. The expenditure to March 1, 1935, had amounted to $68,972.13, about equally divided between the city and the federal funds. The cost of operations was divided, as follows:

Expansion joints	$7,600
Waterproofing streetcar-track pocket and relaying track	30,010
Repair of roadway and sidewalk	1,950
Gunite operation	29,411
Total	$68,971

Organization and personnel

The project has, of course, been subject to all of the delays and cessations incident to carrying on work of this highly technical character with untrained labor. It was found to be impossible to maintain a definite and constant organization throughout, owing to the intricate nature of the work itself and to the varying number of laborers available. The project has been carried nearly to completion without accidents of any kind or other untoward incidents.

The work has at all times been under the direct charge of Paul Jorgensen, structural engineer, in the department of public works, St. Petersburg, with G. D. Wetherington as superintendent of construction. The design and plans were prepared by the division of engineering, public works department. G. A. Youngberg and Carl Weber, of Jacksonville, and E. A. Nordstrum, of St. Petersburg, were retained as consulting engineers on the project.

Current Issues in the Pacific Northwest States

Special Correspondence

THROUGHOUT the Northwest, lumber is such an important factor in prosperity of the region that anything harmful to that industry is serious indeed. This plus the excellent relations between capital and labor in the logging camps and lumber mills makes the recent strike of lumber workers in the Northwest a significant affair.

Organized during the World War, the Loyal Legion of Loggers & Lumbermen (the 4L) has functioned as an industry organization of men and management constantly working for better understanding and cooperative endeavor of employer and employee. Despite the fact that the 4L is representative and effective and although more than 90 per cent of the workmen in reality were opposed to the strike, a very small minority by threats and intimidations forced the great majority to stop work. Therein lies the significance of the strike.

The situation was summed up in a 4L report dated June 1, which states, "For nearly a month more than 35,000 employees have been forced out of work by misinformed or uninformed misleaders of labor." If radicalism can break an industry wide open under these conditions, what may come next? The local reaction has been a decided flare-up against the federal administration, for it is felt that the latter has given support and encouragement to labor organizations in such an unrestricted form that radicalism blazed up out of control.

Some progress has been made toward a "broader viewpoint" in the matter of future power sales in the Northwest. However, much remains to be done, and unless there is better generalship than has yet appeared there are likely to be three camps: Portland, supporting the Bonneville project; Seattle, promoting its municipal power plant on the Skagit River, now in process of adding 120,000 kw.; and Spokane, rooting for its Grand Coulee protégée. The Bonneville and Skagit projects are in relatively definite shape. Grand Coulee has been floundering along, friend and foe alike uncertain as to whether funds for the high dam would be made available and what the policy will be with respect to developing the huge tract of irrigable land in the Columbia Basin, which is the underlying reason for the Grand Coulee dam and power project.

While these major problems of power disposal remain to be settled, Seattle is doing a very excellent job of getting its citizens to believe in municipal ownership of power. Every week-end hundreds of visitors are entertained at the municipal power development in the Skagit River Canyon. A most scenic natural setting has been capitalized by J. D. Ross, the versatile head of the Seattle lighting department, and he has cleverly and effectively utilized the natural attractions of the canyon. The guests visit tropical gardens, at night they view an illuminated waterfall to the accompaniment of soft music, and next day make a boat trip across the great lake behind Diablo Dam, where the water reflects wavering images of rugged snow-capped peaks. In all this the citizen of Seattle is made to feel personal ownership, and he has pointed out to him the economies of municipal management. The clean bunkhouse where he slept and the spotless mess-hall were saved from the construction period; camp, equipment and facilities are rehabilitated city property saved from the junk heap. Meanwhile the net profit of municipally developed power is everywhere stressed and emphasized.

With the quiet efficiency that has taken thousands of Seattle citizens through this week-end of educational experience (at a total cost for transportation, lodging and meals of only $2.50 per citizen), popular support has been developed for the municipally owned electric system, which is certain to be felt in future civic elections.

Of the construction work under way in the Northwest—and all told there is quite a large total—practically every important item is a federal undertaking or at least is partly dependent upon PWA or other federal funds. Thus far the "priming of the pump" very definitely has not produced a reaction that reflects in construction work financed by private funds.

N. B.

Portland, Ore.,
June 18, 1935.

First Federal Housing Is Fireproof Construction

Techwood slum-clearance project in Atlanta, first to be put under construction in the all-federal program, includes 22 buildings with concrete frame and floors and tile and brick walls

START of construction on the first low-rent housing project under the Public Works Administration's $150,000,000 program to finance and build large-scale housing developments on slum-cleared land in more than 30 representative cities provides an opportunity to gage the type and standards of design that presumably will characterize the remainder of the projects as well as any additional ones that may be financed by the new relief-works funds. The project is the Techwood development, at Atlanta, Ga., which replaces thirteen blocks of slums. Comprising 22 buildings of fireproof construction, the development utilizes reinforced-concrete floors with exterior tile bearing walls faced with brick and stone trim. The present status of the other projects in the program, which are beyond the secret land-acquisition stage, is given in the accompanying table.

The first project to go into construction, Techwood is regarded by the Housing Division of PWA as something of an experiment, so far as technical design is concerned. It served as a proving ground in planning and in writing specifications, but in general it can be accepted as indicative of some 40 projects that at present are definitely planned.

The architecture of Techwood is characterized as a modified Georgian. Living standards for tenants set up by the housing division require ample light and air in each dwelling unit, and this is achieved in Techwood by providing cross-ventilation in each apartment.

FIG. 1—CONSTRUCTION UNDER WAY on first federal housing project, Techwood, in Atlanta.

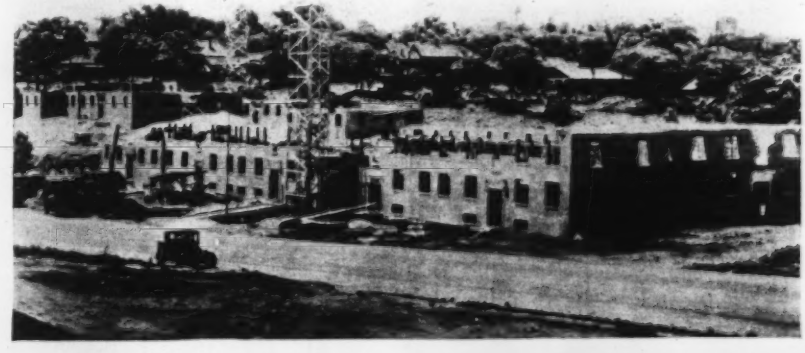


FIG. 2—TECHWOOD housing project, as it will appear when completed, is shown in this architect's panorama sketch.

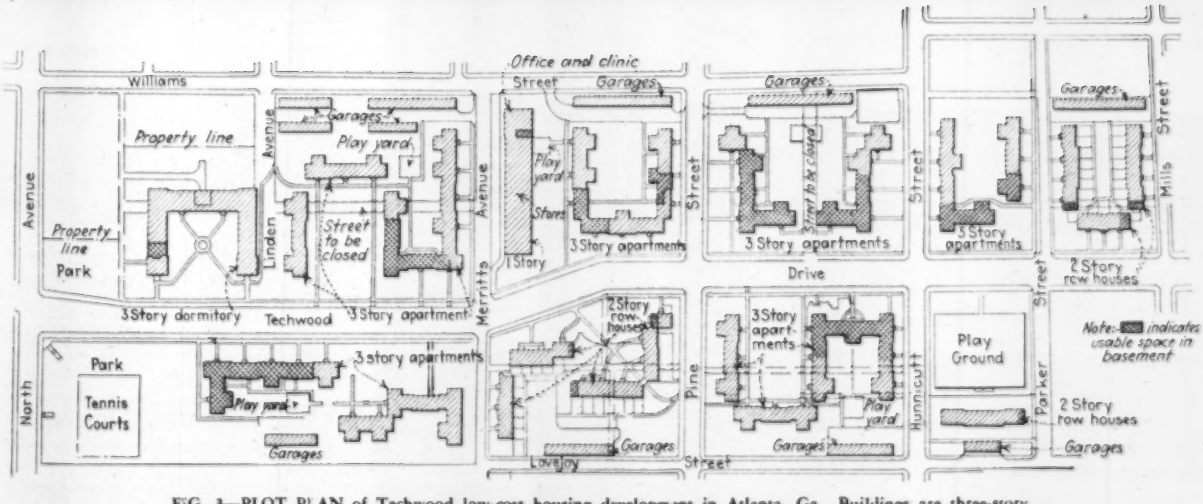


FIG. 3—PLOT PLAN of Techwood low-cost housing development in Atlanta, Ga. Buildings are three-story apartments and two-story row houses. Of the 25-acre site, only about 25 per cent is covered with buildings.

Metal sash is specified for windows. Mastic floors—a combination of asphalt, asbestos and mineral pigment—are used in the bathrooms, asphalt tile floors in living rooms, bedrooms, dining rooms and closets, and linoleum floors in kitchens. Hardware is cast bronze, piping is brass. Hot-water generators, incinerators, gas ranges and refrigerators are among the equipment items.

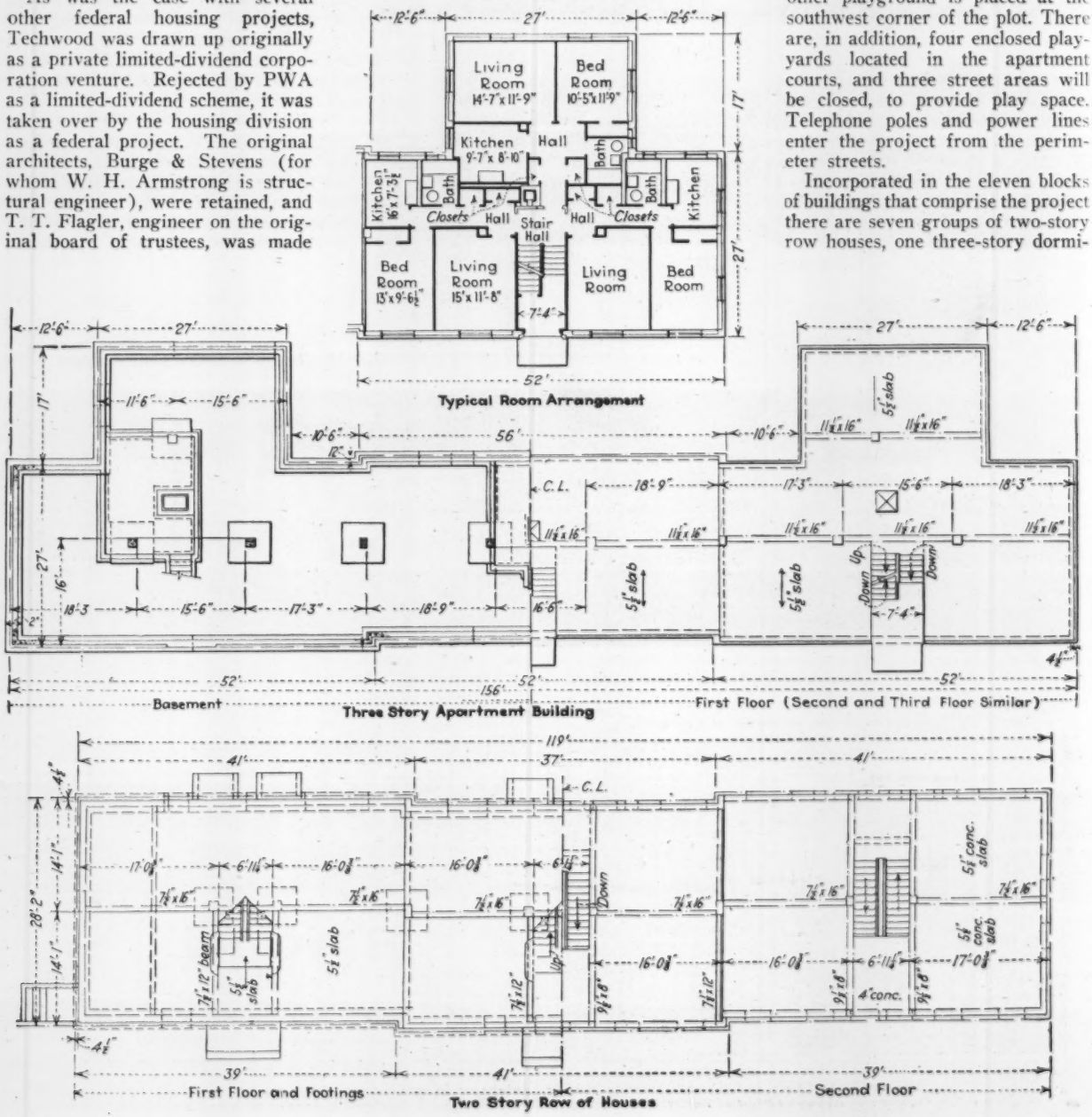
With a view to providing ample recreation and lawn space, buildings will occupy only about 25 per cent of the site. They will front on a new interior street and back up on existing perimeter streets. The general construction contract was let in February to the J. A. Jones Construction Co., Charlotte, N. C., for $2,108,337.

As was the case with several other federal housing projects, Techwood was drawn up originally as a private limited-dividend corporation venture. Rejected by PWA as a limited-dividend scheme, it was taken over by the housing division as a federal project. The original architects, Burge & Stevens (for whom W. H. Armstrong is structural engineer), were retained, and T. T. Flagler, engineer on the original board of trustees, was made project manager for the government. Transferred to federal control in March, 1934, condemnation suits were started on the land April 15. By Sept. 29, demolition of the old houses on the thirteen blocks was started. Families were moved out, and construction began in February, 1935, with 365 days permitted for completion.

The plot plan and the shape and arrangement of the buildings are shown in Fig. 3. Situated just south of the campus of the Georgia Institute of Technology, the plot has a length of six blocks and a width, east and west, of two blocks. The total area is about 25 acres. The north end of the plot, adjacent to the campus, is devoted to playgrounds and tennis courts. The first building to the south is a three-story dormitory containing 159 rooms available to students. In each of the remaining blocks two or three buildings are placed. These are either three-story apartment buildings or two-story row houses, as indicated on the plan. Some of these houses front on Techwood Drive, a new street cut approximately along the longitudinal center line of the development. Garage buildings are placed at the rear of the blocks along the perimeter streets. Another playground is placed at the southwest corner of the plot. There are, in addition, four enclosed playyards located in the apartment courts, and three street areas will be closed, to provide play space. Telephone poles and power lines enter the project from the perimeter streets.

Incorporated in the eleven blocks of buildings that comprise the project there are seven groups of two-story row houses, one three-story dormi-

FIG. 4—TYPICAL FLOOR PLANS of buildings in the Techwood low-cost housing development in Atlanta. Framing consists of exterior bearing walls, a line of reinforced-concrete beams and columns along the longitudinal center lines, and flat-slab concrete floors.



SCOREBOARD OF LARGE-SCALE LOW-COST HOUSING AS OF JULY 1, 1935

PWA Housing

Name of Development	Amount of Allotment	Area		No. of Family Units	Type of Structure	Architects	Contractors	Present Status
		Total Acres	% Building Coverage					
Techwood, Atlanta, Ga.	$2,700,000	24.8	19.5	604	3-sty. dormitory bldgs., 2- and 3-sty. apts.	Burge & Stevens, Atlanta, Ga.	J. A. Jones Const. Co., Charlotte, N. C.	Const. began 2-12-35
University, Atlanta, Ga.	2,500,000	19	25	675	2- and 3-sty. flats and row houses	Edwards & Sayward, Atlanta, Ga.	N. P. Severin Co., Chicago, Ill.	Const. began 4-23-35
Old Harbor Village Boston, Mass.	5,000,000	19.6	27.6	960	3-sty. walkup apts.	J. D. Leland, chairman[1], Boston, Mass.		Condemnation petition filed
West Side, Chicago, Ill.	12,500,000	134.3	18.5	.....	2-sty. row hs.—3-sty. apts.	John A. Holabird, chairman, Chicago, Ill.		Action suspended on original 135 acre project because of land speculation. Smaller site being acquired
So. Park Gardens Chicago, Ill.	5,000,000	56.8	20.1	1,700	2-sty. row hs., 3-sty. apts.	Clark, Wright, chairman, Chicago, Ill.		Condemnation petition filed 10-25-34
Blackhawk Park, Chicago, Ill.	7,500,000	79.3	19.8	2,250	2-sty. row hs., 3-sty. apts.	Robert DeGolyer, chairman, Chicago, Ill.		Condemnation proceedings started
Basin Housing Cincinnati, Ohio	6,000,000	23.7	22	1,278	3- and 4-sty. apts.	Frederick W. Garber and Associates, Cincinnati, Ohio		Land acquisition proceeding
Cedar-Central Cleveland, Ohio	3,279,000	18.2	21	654	3-sty. fireproof walkup apts. and basements	Walter McCornack, Cleveland, Ohio	Geo. A. Fuller Co. Washington, D. C.	Construction bids advertised 3-20-35.; accepted June 10, 1935
Outhwaite, Cleveland, Ohio	2,838,000	20.6	28.7	635	Flats and row house	Maier, Walsh & Barrett, Cleveland, Ohio		Demolition contract let 5-10-35. Plans in preparation
West Side, Cleveland, Ohio	2,791,000	22.3	20.2	600	2- and 3-story apts. and 2-sty. duplex house	J. L. Weinberg, chairman, Cleveland, Ohio		Title to site acquired; plans in preparation
East Side Detroit, Mich.	5,500,000	34.1	21.9	1,032	3-sty. apts. and 2-sty. flats and row house	George D. Mason, chairman, Detroit, Mich.		Declaration of taking filed 5-15-35
Community Hsg. Indianapolis, Ind.	3,025,000	22.1	27.3	1,044	2- and 3-sty. apts. and row house	Russ & Harrison, Indianapolis, Ind.	N. P. Severin Co., Chicago, Ill.	Construction bids advertised 3-25-35; accepted 5-10-35
Louisville Hsg. Louisville, Ky.	1,618,000	11.1	25	460	2- and 3-sty. fireproof apts.	E. T. Hutchings, Louisville, Ky.		Demolition bids advertised. Action suspended pending court decision on legality of condemnation
Parklawn, Milwaukee, Wis.	2,400,000	45.2	13	458	2-sty. row house and flats. 3-sty. apts.	G. J. deGelleke, chairman, Milwaukee, Wis.		Site being purchased. Architects' contract executed
Thurman St., Montgomery, Ala.	244,000	13.8	8.5	158	1- and 2-sty. row and semi-detached houses	Ausfeld & Jones, Montgomery, Ala.		Date of possession of site 3-15-35. Contract awarded 5-3-35
Bell St., Montgomery, Ala.	459,000	6.9	22.7	100	1- and 2-sty. row houses	Carl B. Cooper and Moreland G. Smith, Montgomery, Ala.	T. L. James & Co., Ruston, La.	Construction bids advertised 3-12-35. Contract pending
Nashville, Tenn.	990,000	19.7	15	276	1-sty. row houses and 2-sty. apts.	Richard R. Clark, chairman, Nashville, Tenn.		Site being purchased. Architects' contract executed
Williamsburg New York, N. Y.	12,783,000	21	21	5,000	4-sty. walkup apt.			Demolition bids advertised 3-18-35
TOTAL.....	$78,609,000[2]	614.70						

LIMITED DIVIDEND HOUSING

Name of Development	Amount of Allotment	Area		No. of Family Units	Type of Structure	Architects	Contractors	Present Status
		Total Acres	% Bldg. Coverage					
Altavista Housing Altavista, Va.	84,000	13.04		50	Single-family frame houses	Johnson & Brannon, Lynchburg, Va.	C. L. Lewis, contractor, Lynchburg, Va.	Houses complete
Euclid Hsg. Corp. Euclid, Ohio	500,000			29	Double houses	George B. Mayer, Cleveland, Ohio	12 contractors	18 houses completed and occupied. 31 under construction
Hillside Hsg. Corp. Bronx Borough, N. Y.	5,060,000	13.51	38.50	1,416	Apts.—highest 6 stories	Clarence S. Stein, New York	Starret Bros. & Eken, New York	Under construction. First occupants moved in 5-1-35
Boulevard Gardens Queens Boro., N. Y.	3,450,000	12.93	23	960	Apts.—highest 6 stories	T. H. Englehardt, New York City	B. H. Construction Co., Inc., New York	Under construction. First tenants, 7-27-35
Juniata Park Hsg. (Carl Mackley Hs.) Phila., Pa.	1,039,000	5.53	35	284	3-story apartments	W. Pope Barney, Philadelphia, Pa	Turner Construction Co., Phila., Pa.	Project completed and occupied
Boylan Realty Co., Raleigh, N. C.	198,600	1.15	30.50	54	Apartments	Linthicum & Linthicum Raleigh, N. C.	T. A. Loving Co., Goldsboro, N. C.	Under construction
Neighborhood Gdns. St. Louis, Mo.	640,000	2.51		641	Apartments	Hoener, Baum & Froese, St. Louis, Mo.	H. B. Deal & Co., St. Louis, Mo.	Under construction. First tenants, 7-1-35
TOTAL.....	10,971,600	48.67						

Notes:

[1]In some cities projects are handled by a group of architectural firms, with one architect acting as chairman.

[2]In addition, applications are on hand for 60 more projects in 31 states, totaling $221,507,000, and options are being secured on land in a number of these.

tory, one one-story store and administration building, eleven one-story garage groups providing 186 individual garages, and thirteen three-story apartment buildings providing 604 family units divided into 397 three-room units, 128 four-room, 53 five-room and 26 six-room units.

The type of construction selected for this project was based upon careful analyses and estimates of comparative designs of floor systems. The structural layout for the three-story apartments and the two-story row houses is similar. All of these buildings have a narrow transverse dimension, generally 27 ft. for the three-story apartments and 28 ft. 2 in. for the two-story row houses. This width is divided into two bays by a row of concrete columns and longitudinal concrete beams. The 12-in. exterior walls consist of 8-in. load-bearing tile blocks, faced with 4 in. of selected common brick, bonded every fifth course and trimmed with terra cotta and limestone. The floors and roofs are of solid concrete slab construction, supported by the exterior bearing walls and the interior row of longitudinal beams. In general, the slabs are 5 or 5½ in. thick, reinforced with ⅜-in. and ½-in. diameter bars, and finished with a ⅛-in. troweled monolithic cement finish, to receive the floor covering.

The exposed concrete ceiling slabs, soffits of stairs, beams in habitable areas, and all exposed interior and exterior concrete surfaces are unplastered. In order to insure a smooth finish, plywood-lined forms are being used, and the exposed concrete surfaces are covered with two coats of cement paint.

In general, all footings are of the spread type. The basement walls are of poured concrete 12 in. thick to the ground level, and 8 in. thick, faced with 4 in. of common brick, to the first floor line.

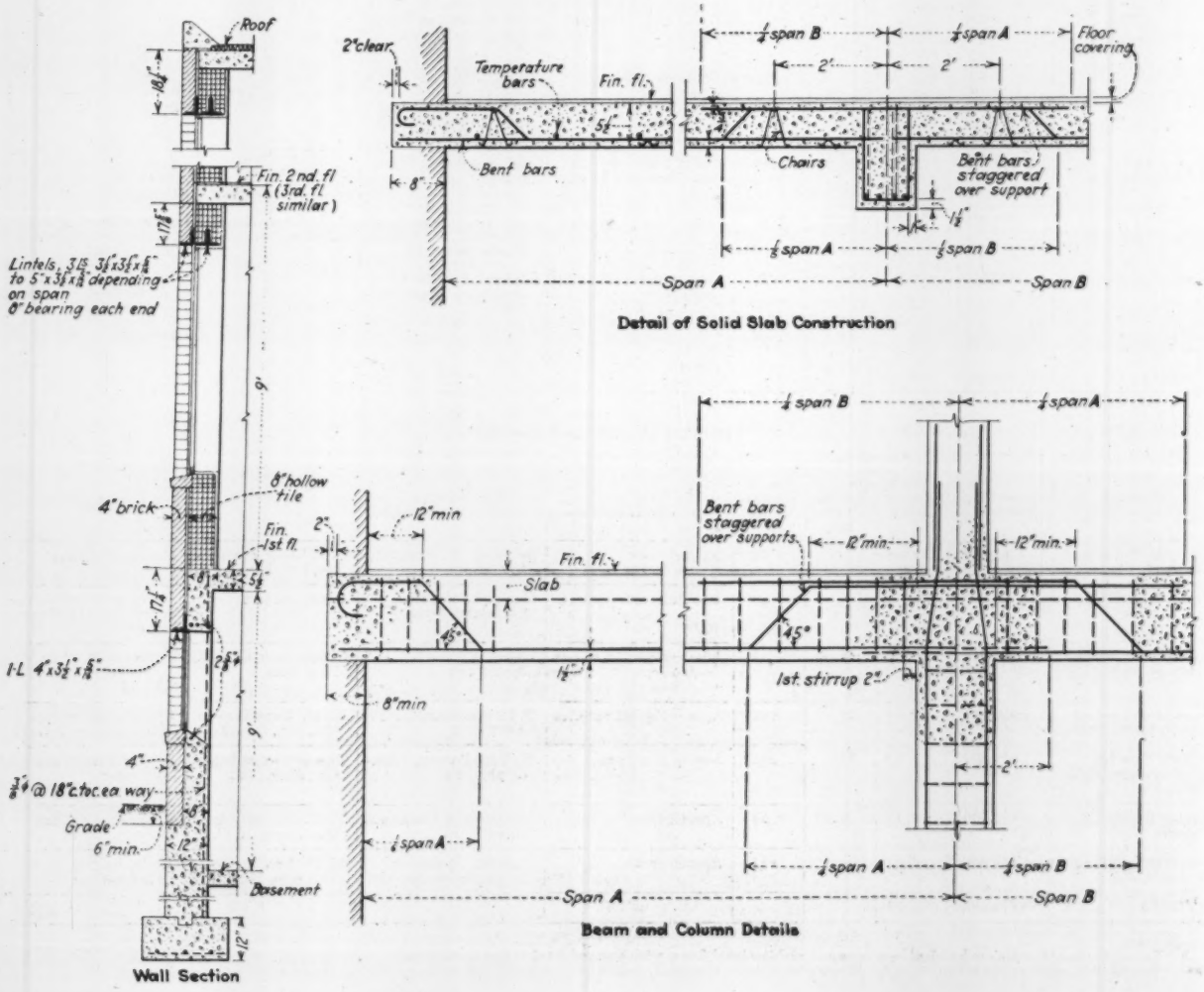
The typical beams in the three-story apartments are 11½x16 in. and in the row houses 7½x16 in. in section. The widths of beams were made to conform to board sizes. Where beams bearing on exterior walls cause excessive load concentration, a backing of solid brick is carried down to the basement wall, in place of the load-bearing tile used elsewhere. Similar construction is used in places where there is 3 ft. or less of wall between window openings. The typical columns are 12x12 in. from the first floor to the roof and 16x16 in. in the basement stories in unoccupied areas.

The specifications require a 2,000-lb. designed-mix concrete, except for a few columns, where 3,000-lb. concrete is specified in order to maintain a minimum size of column in apartments. All concrete is vibrated during placing with an internal vibrator operating at not less than 3,200 impulses per minute.

The dormitory differs in some respects from the other buildings. It is a concrete skeleton-frame structure with wall columns spaced from 18 to 22 ft. and two lines of interior columns spaced 10 ft. apart on either wall of a longitudinal corridor. The outside bays are 12 ft. 4 in. wide. As in the other buildings, there are no transverse beams, the ceilings being smooth in all living quarters. The typical longitudinal beams are 11½x16 in., and the interior columns are 12x12 in. above the first floor. The floor slabs vary from 4½ to 5½ in. in thickness.

The one-story group garages have a

FIG. 5—STRUCTURAL DETAILS used in the first low-cost housing project to be put under construction by the federal government.



narrow transverse dimension of 18 ft. 4 in. and 8 ft. 4 in. wide stalls. The roofs are solid-slab construction 2½ in. thick, reinforced with welded wire mesh and supported on 10-in. steel channels. The side and rear walls of the garages are 8-in. brick and, in the front between the garage doors, are 4-in. H-columns supporting the roof channels.

The store building is mainly one-story except that one end of the building contains an additional floor to house the administrative offices. The type of construction is similar to the three-story apartments except that there are two lines of interior columns, spaced 18 ft. 2 in., connected by longitudinal concrete beams 11½x20 in. in section. The roof slab is 5½ in. thick.

All apartments are designed for 40-lb. live loads, including a minimum partition load of 20 lb. per sq.ft.; all roofs are designed for 25 lb. per sq.ft.

Expansion joints above the first floor have been provided in several of the buildings of unusual lengths. Where wall footings exceeded a depth 6 ft. below grade, it was found more economical to provide concrete grade beams and piers with footings. A 36-in. existing sewer line was encountered in several of the building foundations, which necessitated bridging over the sewer for columns and walls.

All structural details, such as slabs, beams, columns, walls, footings, bending of reinforcing steel, accessories, etc., have been executed in accordance with standards established by the housing division and recently published in a large manual entitled "Unit Plans."

Salt-Stabilized Road Practice Developing Rapidly

Experimental construction and laboratory tests have developed a theory of integral compounding and of salt modification of clay binder that is attracting attention

EXPERIMENTAL road construction, using salt as the element for retaining moisture in a stabilized soil mixture, has been undertaken since 1933 in a number of states including Vermont, New York, Michigan, Indiana, Maryland and Virginia. These salt-stabilized roads have in most instances been experimental sections jointly undertaken by highway departments and salt manufacturers. In general, these roads have been too short a time in service to warrant definite conclusions, but in most cases their behavior in early life has been good. Meanwhile interesting research into the action of salt on clay and salt movement with moisture in road surfaces has been carried on and has developed principles of construction that place salt-stabilized soil roads among the promising types of highways.

Specifically, salt-road experimentation has presented a theory and test data of salt action of clay mixtures as well as general principles of construction and a recommended construction procedure. These developments are summarized here in the order named, using a variety of reports and discussions for information.

Theory of salt action

In simple terms a stable soil, as considered in roadbuilding, consists of a mixture of coarse aggregate, fine aggregate, and binder soils such as clay, so combined as to have strong resistance to lateral flow under load. Soil stabilization is the process of combining the friction aggregates and the clay binder to produce a stable mixture. That the clay may have maximum binding qualities, it must contain moisture. In a road surface subject to evaporation, retention of moisture calls for the addition to the soil elements of a moisture-holding element. In salt-stabilized roads common salt provides this element. For a more extended discussion of soil-stabilization theory, reference may be had to *Engineering News-Record*, May 24, 1934, p. 660, and *Public Roads*, February, 1935.

In addition to its strictly moisture-retaining properties, recent laboratory research by Dr. H. Ries, professor of geology, Cornell University, indicates that salt has a beneficial effect on clay as a binder. If, says Dr. Ries, salt is added to the clay, its general effect seems to be to decrease the volume shrinkage, to increase the shrinkage limit slightly, but to cause little change in the field-moisture percentage. This means less expansion of the clay when it is wet and less shrinkage upon drying. The plastic index is lowered somewhat by the addition of salt but not to a detrimental degree.

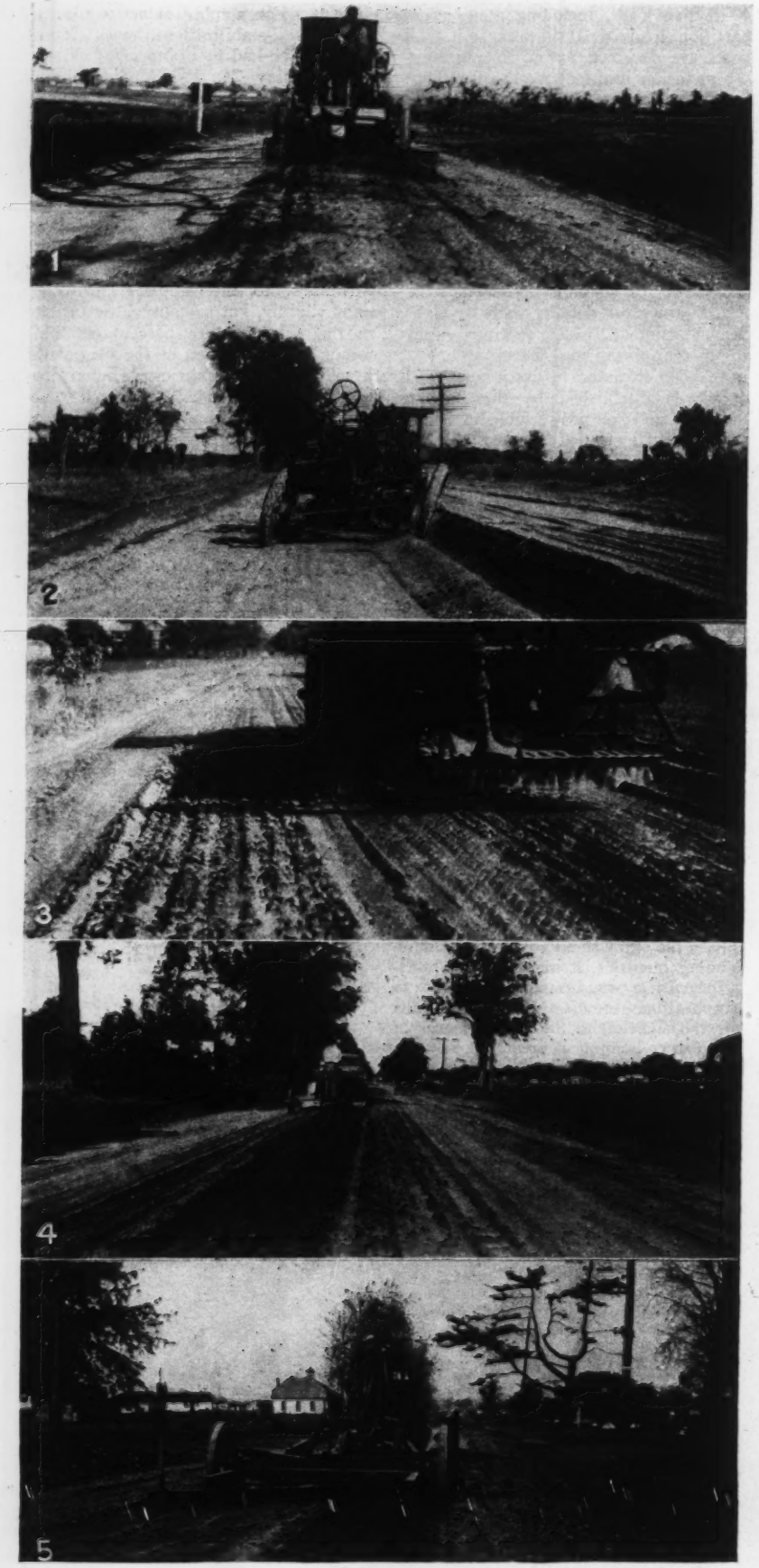
In Dr. Ries' experiments to determine the retentive power of salt for moisture, different amounts were added to the wet clay, and the loss in water during drying both in the air and in the oven was noted. One set of figures is of interest; the clay used was a calcareous glacial clay:

Per cent salt	0	3	6
Per cent water lost in drying 24 hours	14.7	9.96	3.85
Per cent water lost after additional 6 hours drying at 105 deg. C.	.25	2.83	9.78

In a second set of experiments a sandy clay was used, the object being to make the material more porous and encourage evaporation. The clay was mixed with somewhat more water than was necessary to make it plastic, and 6 per cent of salt was added. The samples were then allowed to dry for 120 hours in air, and finally in the oven to constant weight. The results given in the following tabulation show per cent of water retained, expressed in terms of oven-dried clay:

	Per Cent Water		
	Freshly Mixed	48 Hours in Air	120 Hours in Air
Clay alone	26.9	2.19	1.5
Clay with 6 per cent salt	24.1	7.2	2.2

FIG. 1—SALT-STABILIZED ROAD constructed in 1934 near Essex Junction, Vt., after traffic had compacted and ironed out the surface.



It took less water to mix the clay to the same consistency when salt was present, and the salt-treated clay retained a larger amount of moisture.

To test the upward movement of salt through clay, or clay and sand, some 3-in. cylinders containing mixtures of one part clay to one part sand and one part clay to four parts sand, respectively, were made up. The lower inch contained 6 per cent and 12 per cent salt respectively. The cylinders were set in water of sufficient depth to bring the lower surface of the clay columns into contact with the surface of the liquid. In each case the salt had reached the top surface of the column in 24 hours.

More interesting results were obtained when the salt was allowed to percolate downward through a column of soil mixture. For this purpose four different road mixtures were made up, consisting of the proper proportions for stability of gravel, coarse and fine sand, silt and clay, the last forming from 5 to 9 per cent by weight of the mass. These mixtures contained 0, 3 and 6 per cent of salt respectively. The upper end of each tube was closed so that water could be fed to the mixture under a constant head of 15 in. It was found that in each case the percolation was rapid at first and then slowed up, and that this retardation tended to develop not only more rapidly with the salted mixture, but that in three out of four cases the maximum retardation occurred with the 6 per cent salt addition.

Sodium chloride, states Dr. Ries, tends to coagulate a clay; but if the salt is nearly all removed, the clay becomes dispersed. If, therefore, a clay is treated with sodium chloride, it would be leached out of the upper part first, and in the dispersed condition further leaching would be retarded.

Based on these determinations by Professor Ries, the theory of salt action has been developed as follows: Because of salt, water does not evaporate so rapidly from the films surrounding the particles of clay, and when evaporation begins crystals form in the surface pores, creating a crust that seals the surface and retards evaporation. Again salt produces coagulation of the clay particles, which increases the capillary action of moisture, and the moisture films are more evenly distributed. The action then is: when rain falls upon a salt road, the crust salt dissolves and the brine sinks below the surface. The clay then swells slightly, and some of it breaks up into the colloidal condition: the expanded clay and finely divided material close the surface pores and

FIG. 2—SALT-STABILIZATION OPERATIONS as typified by views from several Michigan roads. (1) Stone rake removes large stones. (2) Salt and surfacing material are mixed by power grader. (3) Mixed material is spread and wet to saturation. (4) Surface is shaped up as it dries. (5) Multiple-blade maintainer gives final finish.

prevent further downward percolation. As drying occurs, the brine creeps to the surface, coagulation and recrystallization again take place, and the original condition is restored.

Construction procedure

In proportioning the aggregates and fines for salt stabilization, the standard field practice and laboratory procedure are followed. The distinctive characteristic of the salt process is that the salt is integrally mixed with that portion of the soil mixture that is to form the top layer (1½ to 2 in.) of the surfacing. It is emphasized by the proponents of salt stabilization that it is a body mixture and not surface treatment. The specified procedure is as follows:

The mixture of binder and aggregate shall be bladed to the shoulders of the road. Salt shall then be spread over the sub-base and sprinkled with water in such amounts and in accordance with such methods as may be specified by the engineer.

Sufficient mixed material to form a finished layer not more than 1 in. thick shall immediately be spread uniformly over the moistened sub-base and thereafter compacted, preferably with a 7-ton roller; or, if no roller is available, by heavy wide-tire vehicles; or, if necessary, by the admission of ordinary traffic.

Successive application of water, salt and dry-mixed material shall be similarly applied until all such material is in place on the road. During the process of spreading only enough water shall be applied to maintain the mixed material in a condition sufficiently plastic to permit a maximum degree of compaction.

If, due to rain storms during the progress of the work, the material becomes too wet for proper compaction, the excess moisture shall be dried out; but the material must be shaped with road equipment before it becomes too dry for proper compaction. Similarly, if during the process of compaction, the behavior of any portion of the roadway indicates that too much water has been used, such excess moisture shall be dried out as above specified or by spreading thereon additional dry material.

All over-sized stones that appear during the construction of the wearing course shall be immediately removed.

The essential elements to be noted are: (1) particularized preparation of the foundation bed for the salted surface course; and (2) building up the surface course in layers. Based on the experience obtained in constructing the roads so far built, the approved practice would seem to be as follows:

The material for the construction of salt-stabilized wearing courses should conform to specifications and recommendations issued by the Bureau of Public Roads, which apply to all stabilized roads, regardless of the stabilizing agent used.

The mixture of materials should be so proportioned that when compacted there will be an interlocking of granular particles and sufficient capillarity to furnish high stability during wet weather and enough cohesion in the soil binder to prevent the surface from disintegrating during wet weather. In order to determine when these requirements have been met, the entire soil sample is graded and the plasticity limits determined on the fraction passing the No. 40 sieve.

Material larger than 1 in. may be used but is not to exceed 10 per cent of the total quantity of aggregate, and the size should never exceed one-third the thickness of the stabilized layer. The fraction passing the No. 270 sieve should be less than two-thirds the fraction passing the No. 40 sieve. The percentage of soil fines to be used will vary with the plasticity or cohesiveness and the character of the clay. Soil fines—soil binder—comprise that portion passing the 60-mesh sieve. The soil fines include the clay, silt and fine sand.

The fraction passing the No. 40 sieve should have a plasticity index between 1 and 15 and a liquid limit not exceeding 35, as determined by the physical test methods of the Bureau of Public Roads. (See *Public Roads*, Vol. 12, No. 8, October, 1931).

Generally plasticity indexes of about 3 or less provide sufficient cohesion for unusually wet conditions; 4 to about 8 for average moisture conditions and 9 to 15 inclusive for dry or arid conditions. (See *Public Roads*, February, 1935.)

When the roadbed has been prepared, clay or gravel (or both) are deposited in proper quantities, to stabilize the material in place or in the correct proportion and amount to form the entire stabilizer layer, as the case may be. All stones larger than 1 in. are raked either to one side and removed or go to the sub-base to be spread evenly over the center line to be covered by the stabilized wearing course. No large stones should appear in or near the surface.

The clay, when sufficiently dry, is pulverized with whatever means is available, until 100 per cent passes a 1-in. sieve and not less than 80 per cent passes a No. 4 sieve. Drying of the clay may be hastened by mixing some gravel with it during the drying process. When the clay is dry and pulverized, it is thoroughly mixed with the gravel forming the stabilizing material. This is sampled for uniformity and gradation, evenly spread over the base course, shaped by blading and compacted by rolling or traffic or both, so that the finished road has a cross-slope of not more than ¾ in., or less than ½ in. per foot. The surface should always have sufficient slope to assure adequate drainage.

The rock salt may be spread over the surface material and thoroughly mixed with it before compaction, or it may be added in successive layers with the aggregate while building up and compacting the wearing course.

The quantity of salt recommended is approximately 2 lb. per sq.yd. of road surface and will vary from 8 tons per mile for a road 14 ft. wide to 12 tons per mile for a road 20 ft. wide.

Salt-soil-stabilized wearing courses compact best to a dense hard surface when the total moisture content is about 15 to 20 per cent of the soil fines. In some cases, construction of stabilized roads can be planned so that finishing operations will occur when the clay contains the proper amount of natural moisture. The amount of water required for best compaction is more than sufficient to dissolve all of the salt.

If additional moisture is required for compaction, the wearing course may be built up in layers about 1 in. thick. For the top 3 in. it has been found satisfactory to wet the base course and apply evenly about one-third of the salt. This is followed by about one-third of the prepared aggregate from windrows along the sides of the road. After compacting the first layer, the same procedure is followed in building up succeeding layers. No salt is added to the top layer, but water may be added to aid compaction and smoothing.

Well Drilled Near 35-Ft. Shaft Reduces Unwatering Problem

IN PREPARATION for sinking shaft No. 2 of the Mono Craters tunnel, now under construction by the city of Los Angeles, it was expected that a considerable amount of water would be encountered. To reduce the quantity of water handled in the shaft and to lessen the hazard, it was decided to sink a 16-in. well near by and line it with perforated casing so that water could be pumped from the well during the shaft-sinking. The plan worked well. When the job was visited in April, work on the 70 ft. of shaft put down prior to that time had been very materially simplified by the operation of the well and its pump.

At the start, about 100 g.p.m. was pumped from the well, but after a time the water table in the vicinity was lowered and the well production was reduced materially. The fact that only 15 g.p.m. was pumped from the shaft, which has a total cross-section of about 7½x20 ft., was credited to advance pumping from the well.

Even the inflow into the shaft was materially relieved by a scheme making use of the well. That is, when the shaft had progressed through the overburden, in which a rather heavy surface-water inflow was encountered, a concrete collar was built inside the shaft to collect the inflow from above. Then 3-in. drill holes with a downward inclination were driven from the collar to the well; 2-in. pipes set in these drill holes drained the water collected by the collar into the well, whence it could be pumped out without interfering with shaft-sinking operations.

Cofferdam for 60-Ft. Head With One Line of Sheeting

Single line of steel sheetpiles put to about the limit of resistance by deep water and volcanic sand pressures at Cowlitz River bridge in Washington

By N. F. Helmers
Vice-President Siems-Helmers, Inc., Contractors, St. Paul, Minn.

FIG. 1—COFFERDAM with one line of steel-pile sheeting constructed in 60 ft. of saturated volcanic sand by lowering interior bracing cage with progress of excavation.

TWO river-edge cofferdams recently constructed under the writer's direction to depths of 60 ft. in water-soaked volcanic sand developed external pressure conditions of unusual interest. Adopting a practice from their experience in building the substructure for the Suisun Bay Bridge in California (*ENR*, Jan. 30, 1930), the contractors decided to drive a single wall of steel sheetpiles braced inside with a rectangular cage of timber to be sunk as the excavation proceeded downward. Fig. 2 shows the structure as designed for one of the piers, and that for the other pier was substantially the same; in these plans the depths are to be noted particularly.

Structure and purpose

In December, 1933, the Cowlitz River in Washington rose from a normal high-water level of +9 ft. to an extreme high-water level of +18 ft., scouring out the timber center pier and dropping the steel swing span of the L.P.&N. Ry. bridge near Kelso, Wash., into the river, where the scouring current buried it so deep it was impracticable to salvage it.

This bridge is located across the Cowlitz River 3½ miles below the city of Kelso and about ¼ mile above its mouth where it empties into the Columbia River. The Cowlitz, like most rivers on the west slope of the cascades, is noted for its sudden fluctuation. During the rainy season the river rises as much as 5 to 6 ft. in 48 hours, and the water has a velocity of 4 to 10 miles per hour. The railroad company decided to replace the channel span with a 185-ft. rolling-lift bridge that had previously been used on the Union Pacific Railroad system.

The foundation for the new bridge consisted of two concrete piers (one with two shafts) designed to have the bottom of the seals at an elevation of —60 ft. For further protection against scouring such as occurred in the flood which did the damage, it was stipulated that the piles must be jetted heavily to get as much penetration as possible below the bottom of the seal. The piers were planned to be built in open cofferdams enclosed in steel sheetpiling.

The main supporting pier (Pier 1) for the bascule span was located on the south side of the river and had a base 37x69½ ft. carrying two concrete shafts spaced 42 ft. on centers. The location was such that at the south end of the pier (river end) the ground elevation was —17 ft., while at the north end it was +29 ft. Pier 2, the rest pier, had a base 24⅓x37⅜ ft. with one pier shaft. The river-bottom elevation was about —20 ft. As stated above, the pier base was carried to —60 ft., excavation being carried to —62.5 ft., to allow for swell during piledriver operations.

The profile at Pier 1 (Fig. 2) made the use of floating equipment alone impossible, and the construction methods, therefore, contemplated building a trestle along one side of the pier; this trestle carried a 15-ton whirley with a 70-ft. boom. This was supplemented by a floating derrick also of the whirley type of 20-ton capacity with a 75-ft. boom, both of these machines being of a type standardized by the contractor for heavy bridge work. A small crane was used as an auxiliary.

Cofferdam structure

The illustrations show clearly the detailed design of the timber bracing for cofferdams. For Pier 1 cofferdam there were six sets of timber all having 12x24-in. wales and 10x12-in. struts. Five of these sets were framed as shown by Fig. 2 into a cage by vertical posts of 6x12-in. timbers at all intersections. The last and bottom set, which is designated the drop set, was handled entirely detached from the main cage and was weighted by rails to overcome buoyancy, and then lowered and kept suspended on six wire ropes handled from hand winches. Pier 2 cofferdam was similar in detail except that one additional set of timber bracing was added because the top of the cofferdam is 5 ft. higher than that for Pier 1.

For Pier 1 the steel sheetpile was of the deep-arch type, 80 ft. long, and weighed 271 lb. per sq.ft. For Pier 2 the piles were made 85 ft. long instead of 80 ft. by welding stub of pile to the main pile.

All steel sheetpiling was driven with a double-acting steam hammer. At Pier 1 the sheetpiling had to be driven to practical refusal in order to get it to final required depth of —70 ft., although the driving was aided by heavy jetting, using a 10x6x12-in. double-acting pump and 2½-in. jet pipe with a 1½-in. opening. In driving, careful watch was kept of the effect of the earth pressures.

The sheetpile wall was held from the outside, each fourth pile being bolted to the upper outside guide wale with a ⅞-in. bolt. The inside timber sets were not placed inside the dam until considerable excavation had been made through the water.

Construction procedure

When excavation reached —20 ft., observations indicated a slight movement inward, at which time excavation was stopped, and the drop set was placed in the cofferdam and lowered to the bottom of the excavation. The remaining sets with vertical spacers were then erected. This cage was forced by weighting to sink down on top of the drop set.

Excavation was then carried on, and

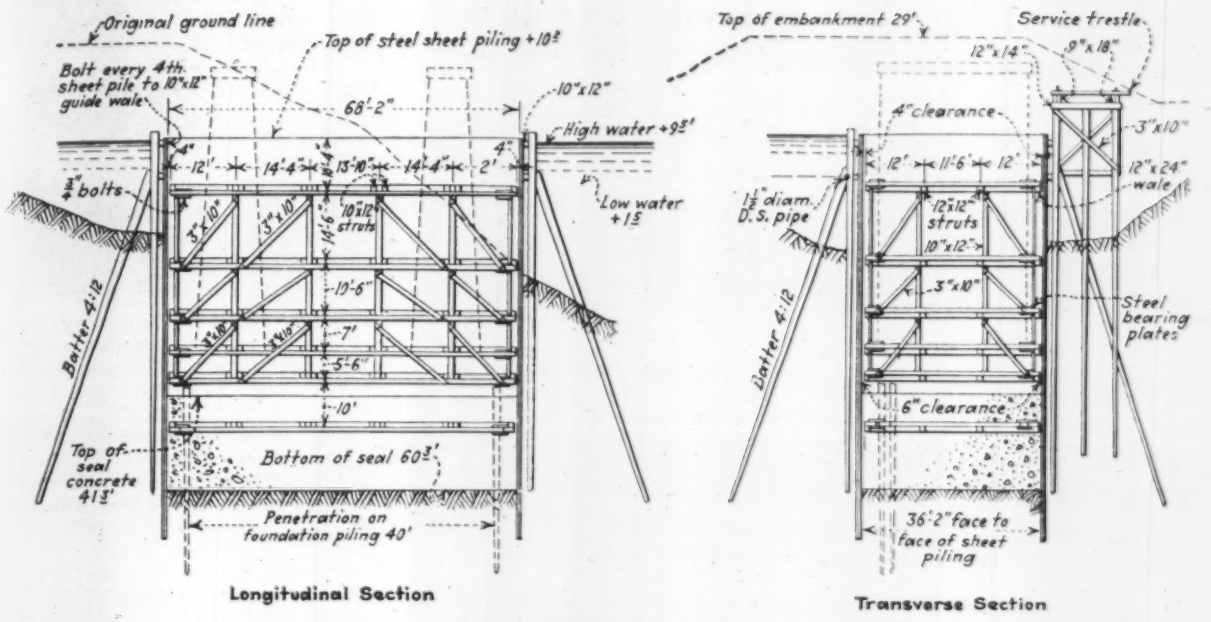


FIG. 2—COFFERDAM for 60-ft. head for bascule pier of Cowlitz River bridge. Note interior bracing cage lowered as excavation progressed, and strong exterior support of guide wales by piles.

simultaneously the main cage and drop set were allowed to follow the excavation closely. When excavation reached about —30 ft., the movement inward of the sheetpile wall became very definite and the cage refused to move farther from the effect of weighting alone.

This is interesting in comparison with the sinking of Pier 2 in Suisun Bay Bridge (*ENR*, Jan. 30, 1930), where a single wall cofferdam, braced in the same manner and built by the same contractor, 58 ft. deep and 46x70 ft. in plan, was constructed and no such pressures were encountered.

To place the timber sets in their theoretical location, according to the cofferdam design, reaction timbers were laid transversely across the dam and hook-bolted to the sheetpiles, and with the aid of eight 35-ton hydraulic jacks and with use of a steam hammer the cage was forced to within 3 in. of its theoretical position, where it came to practical refusal. Any spaces between the wale sets and the sheetpiling were then wedged by a diver. In spite of 2 in. of additional clearances allowed all around for the drop-set, the high external pressures on the sheetpile wall caused such bending stresses in the sheetpiles that a heavy timber spud and steam hammer had to be used constantly to put it down to its final theoretical location. It was then strutted to the main cage and wedged against the side walls.

Report was made to the contractor's general office of the details of these indications of unusually heavy external pressure, and on the basis of calculations made from these reports the field office was instructed to watch carefully for overloading of set 3 due to indicated weight of surcharge. When water was pumped down to expose set 3 the wale timber gave some evidence of crushing across the grain, although heavy steel end plates were used at the ends of each strut to provide proper bearing. An additional set was immediately inserted just above regular set 3 to take care of this excessive pressure. This is particularly interesting in view of the fact that in the original design of this cofferdam the same general assumptions were made as had been successfully used by the contractor on a number of other jobs. Such assumptions were closely in line with other records of standard good practice.

As soon as excavation was completed, the foundation piles, which were furnished in 80-ft. lengths, were driven to an average penetration of 43 ft. below the bottom of the seal. This driving was handled with telescopic swing leads and a hammer equipped for underwater driving. For heavy jetting a 10x6x12-in. pump was used with a 2½-in. jet pipe with 1½-in. water opening. This was the same type of piledriving arrangement as was developed by the same contractor on the two St. Andrews Bay Bridges and the Pensacola Bay Bridge in Florida.

All concrete for Pier 1 was placed with a 1-yd. concrete plant on double-flanged wheels on the service trestle along the downstream side of the pier. The seal was tremied with a 12-in. pipe, 1,809 cu.yd. being poured in one continuous operation. The same concrete plant was moved upon a timber barge together with a whirley crane and used as a floating plant for pouring the concrete for Pier 2.

Much of the construction of Pier 1 was during the period when the river was in flood, the dam being completely flooded when pumping operations started, and again while the shaft work was going on. It is interesting to note that two 4-in. pulsometer pumps kept this dam dry after sufficient head had once been put on the side walls.

The heavy pressure referred to above, which was due to the surcharge of the bank as well as to the general characteristics of the volcanic sand in which the piers were constructed, was further evidenced by the difficulty in pulling the sheetpiles. This operation required a combination of a steam-operated extractor working on three parts of line and a timber A-frame rigged with twelve parts of line with a direct pull on the engine of 15,000 lb. When pulled, several of the sheetpiles had the interlocks sheared off near the bottom, which the writer attributes to the effect of the volcanic-sand friction in the interlock.

The writer believes that, under the conditions existing at the shore pier, the construction approached closely to the extreme practical limit under which sheetpiles could be used; also, that the timbering could not have been successfully handled except for the use of the free or floating drop-set of timber described.

Engineers and contractors

The work is under the general supervision of Bernard Blum, chief engineer; A. F. Stotler, assistant chief engineer; L. B. Curtiss, project engineer; and M. F. Clements, bridge engineer; all of the Northern Pacific Railway Co. The contract is being executed by Siems-Helmers, Inc., contractors, under the direction of the writer.

Progress at Bonneville

Plans for passing streamflow of 700,000 sec.-ft.—Earth cofferdams at power house may be partly removed and replaced—Temporary lock gate—Fishway to cost $3,200,000

A VARIETY of problems well in hand, construction abreast or ahead of schedule, with careful preparations made to handle a heavy summer runoff and very creditable work in placing cofferdam cribs in deep swift water—these are notable features of the present situation on the Bonneville project, the government's first power development on the Columbia now well under way 45 miles east of Portland, Ore.

The spillway dam is located in the main river channel to the right (north) of Bradford Island, and the power house is in the channel on the opposite side; these two channels afford flexibility in the program for river diversion and flood control during construction—a very great advantage where work has to extend over more than one season in a stream whose flow has been as high as 1,170,000 sec.-ft. Up to June 1, actual expenditure on this project has been about $12,000,000 out of the estimated total cost of $42,000,000. The total amount thus far made available is $32,500,000, leaving another $9,500,000 yet to be provided, to complete that part of the project planned for construction now—that is, including the first two power-house units.

Construction schedules, in general, have been maintained. Contracts for two turbines and two generators have been awarded. The present prospect is that first power will be ready for delivery July 1, 1937, about six months ahead of the date originally set. This refers to power from the first two units of 60,000 hp. each, in a plant designed for an ultimate capacity of ten to twelve units.

About $7,000,000 of the difference between available funds and estimated total cost is ascribed to rising construction costs and underestimation of flowage damages, while $2,400,000 of additional expenditure is required for more extensive fishways. Of the available funds $29,000,000 has been paid out or is involved in contracts now in effect; work to be done under the remaining $3,500,000 is practically ready for contract. Much of the work thus far has been excavation, of which there is a total of 4,000,000 cu.yd. on the job, ranging from hard basalt in the navigation lock to wet river bottom dug up within the protection of the cofferdam.

FIG. 1—AERIAL VIEW of Bonneville project with excavation under way in cofferdam on Oregon half of Columbia River channel. To the left, construction is proceeding on the power house and ship lock, while earth dams close Bradford Slough above and below.

Brubaker Aerial Surveys.

Comprehensive articles on the project have appeared in *ENR*, Nov. 1, 1934, p. 547, and Nov. 29, 1934, p. 678.

The spillway dam

Early this year the south half of the cofferdam in the main channel was completed and unwatered. Excellent results were obtained with large timber cribs towed to position and sunk, to form the river and shore arms of the cofferdam. The steel sheetpiling that faced the outside of this crib wall was driven 2 to 4 ft. into the underlying bedrock and made an effective seal. Seepage amounted to only about 65 sec.-ft., some of which came through the steel piling and some through overburden around or under the shore ends of the cribs. Two banks of pumps were installed: the first a three-pump barge with a total capacity of about 50 sec.-ft. and later a bank of six 10,000-g.p.m. units installed in a pump house on the cofferdam.

Although the construction schedule called for only the placing of the cribs before summer floods, it was found possible not only to test them out by pumping down the cofferdam but to remove a total of some 200,000 cu.yd., including some 40,000 cu.yd. of rock by a dragline operating a 9-cu.yd. bucket, a whirley of smaller size and two power shovels.

When high water approached in early April, the equipment within the cofferdam was removed, and the cofferdam was allowed to fill so that when river level rose above the top of the cribs there would be no overpour into the excavation. The cofferdam capacity is 210 acre-ft.

In the deep water along the river arm of the cofferdam the cribs are founded on bedrock into which the protective sheetpiling is driven; hence it is not believed that high water will undercut or otherwise damage this section. On the shore arms, however, the cribs were not put down to bedrock, and it was found desirable to strengthen them.

To determine the nature of flood protection needed at the shore ends of the cofferdam, tests were made with a 1:100 scale model. These showed that scour could be expected at the inshore ends, particularly at the upper arm; a test with pebbles of carefully graded sizes indicated that rock protection on the shore end of the upstream arm should be 3 to 4 ft. in diameter, and on the lower arm 2 to 3 ft. in diameter. Prior to placing this rock, however, a scour crib, 25x60 ft. in plan, was put in the cofferdam at the downstream toe of the fill at the upper arm, and around it were piled boulders which had been sidecast for this purpose during excavation.

From available snow survey records and some special reports obtained during the past three months in the upper reaches of the Columbia River watershed, including Canadian areas, it is considered advisable to prepare for pass-

FIG. 2—EIGHT ACRES of cofferdam in the main river channel. Particularly notable is the uniformity with which separate cribs were sunk into position despite deep, swift water and irregular bottom. Excavation in the cofferdam totaling 200,000 cu.yd. was made this spring ahead of schedule.

ing a flood as great as 700,000 sec.-ft. The height of the peak will be governed by weather conditions and whether run-off peaks from the Snake and Columbia Basins occur simultaneously. It is not expected that a flood of this size will damage the cofferdam or deposit within it anything larger than light material that can be removed easily after unwatering this fall. By the middle of August it is expected that the summer floods will have subsided sufficiently to permit the cofferdam to be again unwatered and excavation resumed.

While awaiting subsidence of floodwater the Columbia Construction Co., contractor for the spillway dam, is installing two 3-in. cableways 1,600 ft. long spanning the river at the dam site and is making preparations for the fall construction season. An exploratory well or test pit is being put down under air pressure on the north, or Washington bank, to determine, if possible, the extent to which there is risk of infiltration of water around the northerly end of the dam. This shaft, 5 ft. in diameter, is to extend down to bedrock and may use air pressures up to 40 lb. per sq.in. The nature of the material traversed and the rate of infiltration into this well are expected to affect final design of the cutoff wall at the Washington end of the spillway dam.

After unwatering the cofferdam, two 36-in. core-drill holes were put down within it, to determine the nature of the Eagle Creek formation on which the dam will be founded and of the andesitic rock beneath. These holes were put down about 60 ft. Other holes are to be put down later.

Power-house construction

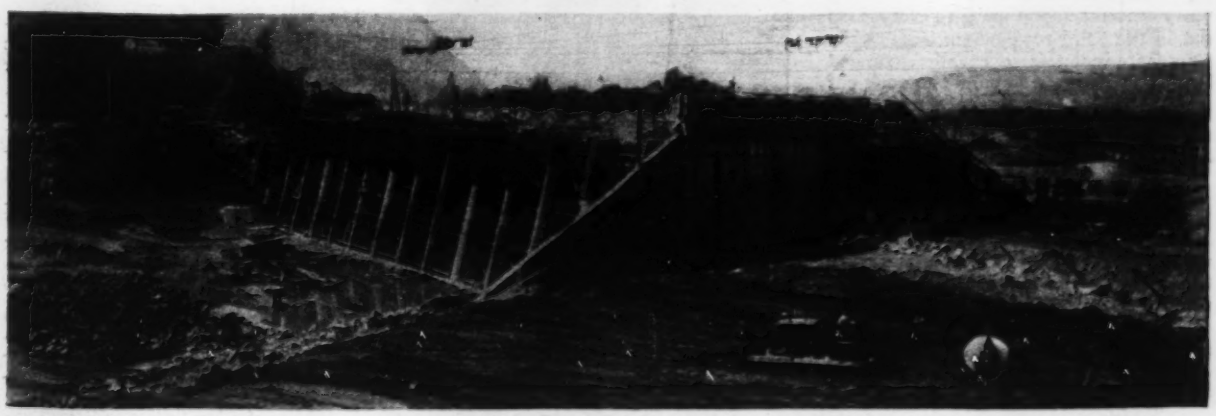
Because the power house is located in the secondary channel known as Bradford Slough it was possible to close off flow through this channel temporarily by means of earth dams, one above and one below the power-house site. Infiltration into the area so cut off was limited by precautionary measures to about the same as that into the main-channel cofferdam—namely, about 65 sec.-ft. Progress on the power-house substructure, which includes headworks and draft-tube outlets, will be completed by the end of November, 1935; thereafter the earth dams will be permanently removed.

Meantime it is possible but not probable that the summer flood will be more than can be handled safely in the main river channel. For floods exceeding 700,000 sec.-ft. some of the water will have to be passed through the power-house channel. A determining factor in this question is the railroad track on the Oregon side of the river, the O.W.R.&N. line, which has not yet been raised to the relocation that will put it above the high-water level caused by completion of the Bonneville project. By raising the track 18 in. for a length of only 600 ft., an 18-in. increase in water height of the flood level in the main river could be allowed. Beyond that, relief from high backwater above the cofferdam which now obstructs the main channel must be provided through Bradford Slough. If necessary, openings will be made in the earth dams above and below the power house, and later, after the floods have subsided, these gaps will be replaced until the power house and lock are completed.

The present power-house contract, which includes also the lock, calls for about 240,000 cu.yd. of concrete, of which 115,000 cu.yd. is in the lock. About 90 per cent of the concrete in this part of the work had been placed by June 1. Materials are assembled on Bradford Island and mixed in two 3-yd. concrete mixers; a car takes a two-batch load to the 6-yd. cableway buckets. The cableways have a common tower on the island, and the ends on the Oregon shore are on travelers, thus enabling the cables to deliver to nearly all parts of the power house and headworks. Concrete is pumped to some parts of the job not within reach of the cableway. Vibrators are used in placing all concrete.

This contract, held by the General Construction Co.—J. F. Shea Co., includes placement of a roadway deck

FIG. 3—INTAKE to the Bonneville power house. Retaining wall in foreground divides present and future powerhouse structures. Navigation lock is in rock cut at extreme left.



over the draft tubes, thus giving access to the island during flood stages of the river. Contractors working on the island are promised use of such a roadway by the time the roadways on the earth dams have to be closed. Contract for the power-house superstructure is expected to be awarded about Aug. 1.

Navigation lock

The navigation lock, which is to cost $4,000,000, will have a usable length of 500 ft., will handle vessels with a draft of 26 ft., and constitutes a world record for lift in the 66-ft. maximum difference (59-ft. normal) between headwater and tailwater. Much of the ship lock is excavated in hard columnar basalt. The excavation has been completed except for portions of the approaches, and half the 113,000 cu.yd. of concrete in the lock structure was in place June 1.

The lock work has been held back slightly by giving priority to construction on the power house. This had to be done because the impending flood season made it necessary to speed up work in Bradford channel. The bridge across the lock at its lower end is part of the Bradford Island access roadway and hence has been rushed accordingly. This bridge has a span of 100 ft. and is of the swing type with a bobtail counterweight. Last-minute revisions of design provide for a roadway 22 ft. wide, to accommodate two-way truck traffic during construction, as well as a standard-gage track set flush with pavement surface. After the construction period the bridge is to be redecked for a single-track roadway with sidewalks.

A construction feature of the lock is that it is designed to pass river traffic during the construction of the spillway dam in the main channel. For this reason a notch 45 ft. wide and 22 ft. deep was left temporarily in the wall constituting the upstream end of the lock, and this opening will be fitted with a temporary timber miter gate for the single season that it is expected to be in use. Later the notch will be filled in with concrete, and the larger, permanent miter gates will be installed in their recesses at the higher level.

A striking feature of the lock construction is the excavation of a fishway entry into the lock through a very deep cut in the solid rock on the north side. Contract for this excavation ranged from $5 to $6 per cu.yd. The rock cut for the lock itself is spectacular; in some places it is 70 ft. deep. Concrete lining is anchored to the sheer walls by reinforcing rods grouted 8 ft. deep in the rock (or more where rock is seamy) and with projecting ends hooked to pass around other steel bars in the facing.

On the Washington side of the river the relocation work of the S.P.&S. Railroad has been completed. Of the relocation on the Oregon shore about 50 per cent is completed, and much still remains to be done because of heavy excavation involved in two large cuts and construction of a concrete viaduct. The cuts are about 90 ft. deep and involve a total of over half a million cu.yd. of excavation. The viaduct is 780 ft. long, is laid out partly on spiral and partly on curve, and consists for the most part of 50-ft. concrete arches.

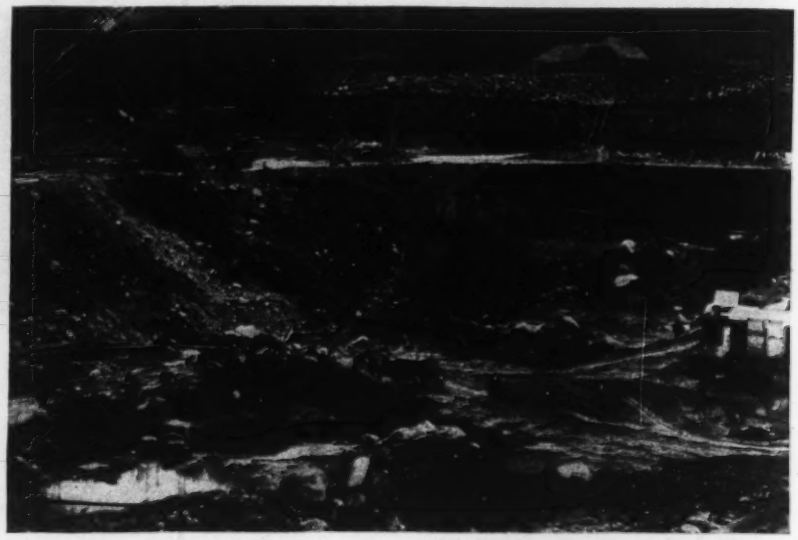


FIG. 4—LARGE BOULDERS AND SOFT FOOTING for trucks combined to make cofferdam construction difficult. Photo was taken from cribs looking toward shore.

Fishways

Because of the importance which Oregon and Washington attach to the fishing industry in the upper Columbia River, exacting requirements were insisted upon in the matter of means for passing fish up the river around the dam and power house. Although not yet finally completed, present plans contemplate the placement of fish ladders at either end of the dam at the north end of the power house and one south of the lock and also provide access to the navigation lock from below the power house by means of the channel already mentioned. This route will also be provided with a pair of fish locks or elevators, and another pair will be placed at the north end of the dam.

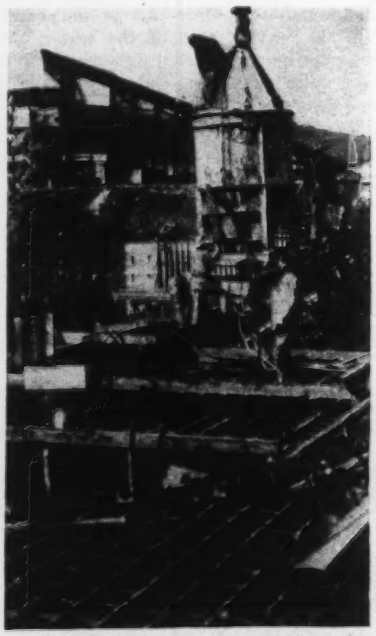


FIG. 5—PLACING CONCRETE in the power house from a 6-cu.yd. bucket.

The army engineers' original estimate for fishways around the Bonneville Dam was $800,000. From time to time this figure was increased on the insistance of fishery interests until the present plan contemplates an expenditure of $3,200,000. Application is pending for still further modification of this provision for fishways, but inasmuch as the present plan has been finally accepted and approved at Washington further change is not expected.

The total number of men employed on the project at the height of the work was about 3,500. Closing down work on the cofferdam during high-water season dropped the number of employees to about 2,300 in early June.

Personnel

The Bonneville project is being constructed under the direction of the Corps of Engineers, U. S. Army, Maj. Gen. E. M. Markham, chief of engineers. The staff at Portland consists of Col. T. M. Robins, division engineer; Major C. F. Williams, district engineer; Major H. A. Skerry, executive officer; and C. I. Grimm, chief civilian engineer. Heads of departments in the work of design and specifications are as follows: railroad and highway, A. E. McKennett; spillway dam, R. R. Clark; power house, C. C. Galbraith; navigation lock, Ray E. Mackenzie; fishways, B. L. Peterson. Capt. J. S. Gorlinski is resident engineer and B. E. Torpen construction engineer at Bonneville.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, these short abstracts of articles and papers published in languages other than English are presented monthly. In these abstracts no attempt is made at a compendium of foreign-language articles, but selection is made from articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness.

Previous groups of these abstracts from foreign periodicals have been published in *Engineering News-Record* of Jan. 31, Feb. 21, March 28, April 25 and May 30, 1935.

Polish bridge strengthened

The strengthening of a 62-year-old steel bridge at Thorn, Poland, by an added line of trusses is described by A. Eberhardt in *Przeglad Techniczny* of Feb. 7, 1934. The bridge is 3,189 ft. long across the River Vistula and has seventeen spans, five of which are each 319 ft. long. One-third of the bridge length is curved to a radius of 1,235 ft. Its superstructure, which was completed in 1873, had been designed for a live load of 2,350 lb. per foot. This is inadequate for modern railroad traffic, so that an economic method for its strengthening had to be determined.

Tests showed that after 60 years of service the steel was quite sound: 48,400 to 55,600 lb. per sq.in., with an elongation of 17.5 to 21 per cent.

It was found that the cheapest strengthening method was to add a third truss to each span which, incidentally, would separate the highway from the railway traffic, allotting a width of about 19 ft. to the first and 16 ft. to the second. The main features of this third girder, which is a "rhomboid" truss reminiscent of our Baltimore type, are shown by Figs. 1 and 2. Computations demonstrated that its rigidity was to be 2½ times that of the old girders.

Interesting and novel structural details had to be devised for incorporating the new girder in the old structure. The future permanent deflection of the new structure was taken care of by inducing calculated stresses and deformations at the proper points. Railroad traffic was maintained throughout the construction period.

Concrete flume of noval design

A reinforced-concrete semi-circular aqueduct of bold design, now under construction at Tardienta, in the province of Aragon, Spain, is briefly described by its designer, Professor E. Pena Boeuf, in *Revista de Obras Publicas* of April 1, 1935.

This flume, being built for Conferacion Hidraulica del Ebro, is essentially a continuous semi-circular trough 2,877 ft. long (Fig. 3) of an interior diameter of 24 ft., supported on reinforced-concrete bents, averaging about 35 ft. in height, spaced 49.2 ft. apart. The footing slabs of these bents, which are 32 to 39 in. thick, are laid at a variable depth up to 20 ft. under the ground surface.

The cross-section of the trough is practically a crescent, varying in thickness from about 6 in. at the high-water level to about 28 in. at the bottom. The sides of the trough are prolonged about 2 ft. tangentially upward and are cantilevered inwards to form two parallel footwalks about 4 ft. wide. Thus, the over-all outside dimensions of the trough are about 25 ft. wide by 17.7 ft. high. The bearing surface between bent and trough is protected with a lead sheet about ⅛ in. thick.

The trough is designed as a continuous structure, subject to transverse and longitudinal deformation, with variable tangential shear, which ranges from about 43 to 85 lb. per sq.in. This design, subsequently checked by full-scale tests, resulted in a saving of about 20 per cent over an equivalent rectangular trough. Furthermore, the usual assumption of uniform shear throughout the tension zone, which, according to the author, is utterly unwarranted, would have resulted in the prohibitive shearing stress of 327 lb. per sq.in. at the thin top section of the trough, instead of 43 lb. per sq.in.

To check this daring design, which was the subject of bitter controversy, the first five-span section of the flume, 246 ft. long, was subjected to a thorough test in February of this year. A wooden bulkhead supported by an 8-in. interior rib stopped the downstream end of the trough, which was subsequently filled with water about 10 in. over and above its high-water level. The water was allowed to stand overnight. Precise measurements completely justified the theory of the design, and further construction to completion was ordered.

Temporary tierods used during construction are removed after the concrete has hardened.

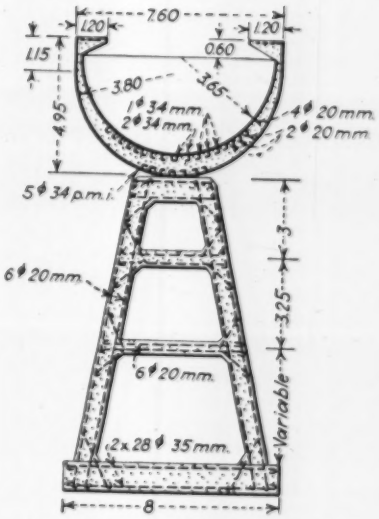


FIG. 3—SEMI-CIRCULAR FLUME of reinforced concrete at Tardienta, Spain.

FIG. 2—SECTION of old bridge at Thorn, Poland, showing new strengthening truss.

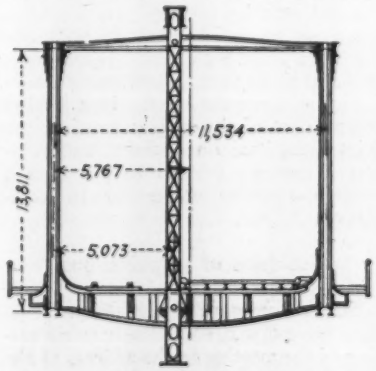
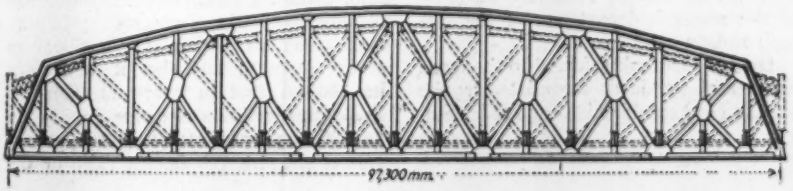


FIG. 1—ELEVATION of strengthening truss of bridge at Thorn, Poland, showing outline of existing trusses by dash lines.



Materials Research and Standardization Increasingly Active

Detroit meeting of A.S.T.M. reflects marked revival of effort in the field of materials and produces many advances in specifications and important research results

DEFINITE RETURN toward pre-depression activity in the field of materials was apparent in the proceedings of last week's meeting of the American Society for Testing Materials at Detroit. In volume of work accomplished as well as in the spirit of the committee and general sessions the meeting reflected a noteworthy change from the conditions prevailing during the past two years, when industrial sluggishness retarded investigation of materials and development of specifications. Resumed growth of membership reported by C. L. Warwick, secretary of the society, gave confirmatory evidence of this change.

Plans for extending the society's work into new fields in response to demands presented during the past year are further indication of the current strong revival of interest in the materials field. Study of gaseous fuels is to be taken up, and methods of chemical analysis of metals are to be organized systematically; consideration is being given to entering the field of paper products and of detergents. Cooperative work with other societies is also in course of fuller development, in particular through close cooperation with the American Railway Engineering Association in the field of railway specifications and with the American Standards Association in the adoption of national standards.

The main work of the meeting has heretofore been in the field of metals, cement and related structural materials, but important results were accomplished also in road materials, oils, rubber and textiles. Improvement of specifications claimed the major share of attention, particularly as more than 100 committee meetings were held at convention headquarters during the week, many of them concerned with last-minute changes in specifications to be presented to the society for adoption. But research papers contributed a number of important additions to knowledge of properties or test methods.

Several symposium and open-discussion sections tended to relieve somewhat the intense specialization inseparable from the technical work of the specifications committees. One of them dealt with the interrelated subjects of road, tire and automobile. Another, the annual dinner session, was concerned with housing. An open discussion of yield strength occupied one of the technical sessions. The Edgar Marburg lecture, delivered by Dr. L. B. Tuckerman of the Bureau of Standards, discussing problems of aircraft materials, was another significant feature of the meeting.

Among the contributions to research, discussions of corrosion and of fatigue were important. A monumental study of fatigue failures of spiral bevel pinions in rear-axle differentials, carried out by full-size axle-assembly tests at the General Motors Laboratory, made a major addition to knowledge of fatigue factors. The distribution of strength in timber was newly illuminated. A new approach was made to study and control of corrosion of steel parts, particularly pipe. Development of an abrasion machine for testing wear resistance of coarse aggregate promises to advance the practical rating of crushed stone and gravel. New advances in the study of shrinkage of concrete were reported. In a number of special-materials fields, similarly significant development of knowledge was recorded.

Among the specifications, important results to construction include the decision to examine critically the standard definition of portland cement, the postponement of action on advancing the high-early-strength cement specifications to standard and the absence of progress in specifications for blended cements. The bridge and building steel specifications were amended by including regulations for patching surface defects by welding. Structural timber designations were changed from grade markings to stress values. Some progress was made toward developing a durability measure for brick. In a session independent of the society meeting, the joint committee on concrete and reinforced concrete carried its work on a modern specification nearer to completion.

Problems of specifications

Some important specification problems were discussed at the opening session of the meeting in the address of Dr. Hermann von Schrenk, retiring president of the society, and in an address on "The Relation of Specifications to Engineering" by Dr. C. F. Hirshfeld, chief of the research department of the Detroit Edison Co.

Dr. von Schrenk referred to the large number of standards formulated by the society (442 specifications and 261 methods of test), as well as the extent of its present committee work (76 committees, some with 200 members and more than 20 subcommittees), and remarked that the work has become too highly specialized: "Often members of the same committee do not understand each other." He suggested a development of the symposium method as a device for tying the specialized work to the practical interest of the membership at large.

As illustrating the far-reaching interdependence of specifications with design, Dr. von Schrenk took the case of dwellinghouse construction, an operation that involves more than 90 of the society's specifications. Deficient quality of the nails that hold down the shingles not only shortens the life of the roof but also contributes to the conflagration hazard of loose shingles and in turn leads to passage of prohibitory laws against wood shingles—all because of failure to correlate the qualities of materials with the uses to which they are put.

Dr. Hirschfeld, after describing a specification as a means of defining the user's needs, in order that the producer may know what to supply, pointed out some of the limitations of such definition. Often, as when word is required to have straight grain, the desired result is not readily stated in quantitative terms; moreover, departure from straightness of grain is important only in its effect on use properties. Since the application of materials always tends to forge ahead of knowledge of their properties, many specification terms must be drawn from practical experience, and quantitative measure of service requirements is not always possible. He illustrated this further by telling how a tentative specification for rubber springs to replace certain metal springs has been developed on a descriptive basis resting on crude experience and is producing satisfactory springs, but that a formal precise specification must wait until rubber manufacturers obtain fuller information on the properties in terms of desired service. Dr. Hirschfeld therefore asked for energetic continuance of the study of material service and properties, to assist in writing better specifications.

Edgar Marburg lecture on aircraft materials

The annual Edgar Marburg lecture was delivered by Dr. L. B. Tuckerman, of the Bureau of Standards, who discussed the problems of aircraft materials. Lightness and structural strength, he said, make the strength-density relation of such materials of controlling importance. By an illuminating application of the strength formulas of mechanics he showed that in every member or shape this relation depends jointly on (a) the properties of the material (either the strength-density ratio or the

modulus-density ratio), (b) a shape factor such as the thickness-length ratio, and (c) a factor dependent on end conditions, stiffening and other features controlled by the designer. Analyzing further the effect of the thickness-length ratio on primary failure and the several different types of secondary failure or instability, he pointed out that primary strength usually varies inversely with the thickness-length ratio, while resistance to secondary failure (crumbling, twisting, dishing, etc.) varies directly with this ratio. Strength of member is therefore determined by an intersecting group of curves, whose relative position is largely fixed by design. In precise estimation of strength, moreover, not only these main curves but also their connecting or transition curves must be considered. Supporting this analytical exposition by ingenious experimental demonstration and by pictures of test failures, which afforded practical illustration of the phenomena discussed, he showed how far the mechanics of design for maximum lightness per unit of member strength goes beyond the limits of analysis applicable to the more common applications of structural design. Success in adapting materials to aircraft use depends, he concluded, on thorough study of the properties of materials coupled with refined analysis of the theory of strength of structures.

Housing materials

Materials and modern housing comprised the theme of addresses by M. L. Colean of the Federal Housing Administration and by J. E. Burchard, vice president of Bemis Industries, Inc., Boston. FHA has established minimum requirements for houses that it insures. These requirements, considerably above present average, are still low but will be progressively raised as costs can be lowered and public acceptance of better building grows, according to Mr. Colean. New materials are welcomed by FHA, and its engineers are continuously working with sponsoring groups on studies and tests that must precede FHA approval.

Mr. Burchard gave a comprehensive review of past and present efforts to make the prefabricated house a salable product. The many new and improved materials, natural and synthetic, that are available, the aroused interest of engineers and architects and the successive (if unsuccessful) attempts to develop a really low-cost house for a new class of home owner are regarded by Mr. Burchard as hopeful signs for the prefabricated house.

C. F. Kettering, vice president General Motors Corp., offered some timely warnings to the embryonic modern house industry. "Don't make your specifications too tight or carry standardization too far; above all, do not carry standardization to monotony and do not let the prospective owner suspect that he is buying a standardized product." Mr. Kettering also suggested that more success might be attained more quickly if modern houses were not so radically different in appearance from those to which we have been accustomed.

Roads, tires and automobiles

Many facts and views on the development of roads, tires and automobiles and on the relation of specification work to these subjects were brought together in an evening's symposium on "The Place of Materials in Automobile Roads and Rides."

High spots of the symposium were Prof. John S. Worley's statement of the development of the road and some of its current problems, and an address on tire development by K. D. Smith, of the B. F. Goodrich Co. These were ably supplemented by an extended listing of needs and possible advances in automobile design, by O. T. Kreusser, of the Chicago Museum of Science and Industry, formerly director of the General Motors Proving Ground, and by discussions of individual auto and tire problems by various automobile men. The work done by the society's committees on materials of road and automobile construction and on fuel, oil and rubber, was outlined by their chairmen.

Prof. Worley asserted that our present roads are really only neighborhood or local roads, and that they are not in keeping with the vehicle that travels on them. This is serious because 70 per cent of the country's passenger traffic is on the highway, and our total passenger transportation is eight or nine times as great as it was twenty-five years ago. The improvement to be sought for is the construction of through trunk roads for long-distance traffic, connecting with cities over short lengths of neighborhood road; the trunks should have a 200-ft. right of way, two separated traffic ways, structures and business kept away by full fencing, 1500-ft. sight distance everywhere, grades on which all vehicles can maintain at least 20 m.p.h., and a surface as plane as possible —this in view of the fact that accidents are now resulting from minor irregularities of surface not noticed at former slow speeds. Subgrade studies are essential to make such roads possible. Signaling must be developed more efficiently, and lighting requires consideration.

Mr. Smith presented a comprehensive survey of tire function. The tire must serve as an envelope of air to carry loads, but must be able to flex in order to cushion shocks. It must meet widely varying requirements, as heavy abrasion but light carcass duty in Florida, as against less abrasion and more bruising in the North. It must have skid resistance despite variation of friction coefficient from 0.1 to 0.7. It must be made quiet, if necessary by varying the size of the buttons, and thump at projecting pavement joints must be overcome. It must also allow easy steering.

Materials, construction, accelerators, study of aging prevention, have improved tires so that a curing time of many hours has been reduced to 5 or 6 minutes for tubes; aging is overcome; mileages have increased from 2,000 or 3,000 to 20,000 or even 50,000. Mr. Smith added that we have about reached the limit of what can be done with present materials, but we have not reached the limit of speed or of low air pressure. In discussion, an automobile research engineer characterized American concrete roads as the worst in the world, and traced this to the fact that wavelength has been ignored. According to his analysis is the unsprung parts of present-day automobiles have a vibration frequency of about 9 per sec., the sprung masses 1 to 2 per sec.; at 45 ft. per sec. city speed or 90 ft. country speed, this implies resonance wavelengths of 5 to 10 ft. for the unsprung masses and 20 to 45 for the sprung masses, the later figure not far from the length of road construction units. Laying pavements in sections of odd lengths was suggested. F. C. Lang, of the Minnesota Highway Department, supplemented Prof. Worley's views by saying that we must look toward a complete modern road system, from farm road to trunk road, but that to accomplish this we must learn to do more with less money, a matter largely dependent on better subgrades and hence soil study.

Corrosion research

Some new results of the several extended series of corrosion exposure investigations being carried on by several committees were reported at the meeting, but no conclusions were presented.

Exposure tests on wire screens of various metallic compositions begun in 1924 were completed last year and a report by G. W. Quick (Bureau of Standards) summarized the results. Screens were exposed at Pittsburgh, Washington, D. C., Portsmouth and Cristobal, C. Z. They were rated according to tensile strength after 9 years' exposure. Seven compositions of screen were studied: (1) 90 Cu, 10 Zn; (2) 80 Cu, 20 Zn; (3) 75 Cu, 5 Zn, 20 Ni; (4) 30 Cu, 70 Ni; (5) 100 Cu; (6) 98 Cu, 2 Sn; (7) 95 Cu, 5 Al.

Screen No. 6, a special tin bronze, was the best in all locations, followed by screens 5, 1 and 3. The aluminum bronze was not good in industrial atmospheres. The nickel alloys were not durable in industrial atmospheres and questionable in marine exposure. On the other hand, in salt spray tests the screens rated in order as follows: 3, 4, 6, 5, 7, 1, 2.

Corrosion investigations were reported in three papers. H. S. Rawdon and L. J. Waldron, of the Bureau of Standards, described a method for testing pipe corrosion in which different pipe samples 5 in. long are coupled by

rubber couplings, and a continuous flow of water circulates through them. The loss of weight per unit of inner surface after the desired length of exposure is determined. It was found that the rate of loss differed for the entering and leaving sections of pipe at low flow velocities, but at velocities of 25 to 30 ft. per min. this difference disappeared. The rate of corrosion appeared to increase with increased length of exposure, probably because the exposed surface became rougher.

Corrosion-test apparatus

A spool-type specimen holder for field corrosion tests was described by F. L. LaQue (International Nickel Co.). Having used it for eight years Mr. LaQue presented it as a practical apparatus that eliminates the hazards of damage to the test specimen, and prevents specimens from being lost or suffering galvanic effects. Discussion centered on standard methods of expressing corrosion. R. F. Passano (American Rolling Mill Co.) pointed out the difficulty of expressing corrosion as a rate of deterioration when corrosion and time do not have a linear relationship. In those cases it may be best to utilize the amount of corrosion in a unit of time. F. N. Speller, in another session, asked that corrosion loss be stated in inches depth rather than milligrams loss per square decimeter.

Corrosion and air-conditioning

The growing use of air-conditioning is creating a new field in which corrosion must be combated. C. M. Sterne (Metropolitan Refining Co., New York) reported results of a number of tests run during the past few years on plate specimens mounted in equipment in building and industrial plants. Some fourteen different chemical treatments of the water were used, with the result that sodium dichromate when used in sufficient amounts (50 to 500 p.p.m.) was found to give the best protection. It was also effective when used in combination with sodium silicate. The sodium dichromate, being an oxidizing agent, is also efficient in eliminating organic odors from the washwater.

New facts on fatigue of metals

A remarkable report on fatigue tests of full-size machine parts, by J. O. Almen and A. L. Boegehold of the General Motors Corp., Detroit, brought out new facts of much importance to fatigue knowledge. Several hundred complete rear-axle assemblies were run in a motor-driven test rig under full low-gear torque to failure, which nearly always was the fracture of one or more differential-pinion teeth. The axle gearing tested was of numerous different sizes, designs, and quality of machining. When the tooth stresses were plotted against number of cycles at failure, a typical fatigue stress-cycle plot was obtained. Excessive scatter of the observation points was found when the stresses used in this plotting were calculated by the usual Lewis formula; using a later tooth stress formula of McMullen and Durkan, however, close and consistent plots were obtained.

Correlating the tests with automobile service records of different gears, it was found that the tests paralleled service. Study of the effect of perfection of machining of the pinion teeth on their life showed very large notch-weakening or stress-concentration effect of poor cutter finish at the root of the teeth.

The authors concluded that the gear failures both in test and in service were fatigue failures under repeated cantilever loading of the pinion tooth, and that variations in design and manufacture have greater effect on gear life than variations in material or heat treatment. Impact tests are not significant. Notched-bar fatigue tests correlated well with the results of the axle-assembly tests. The weakening effect of stress concentration arising from the reentrant angles caused by rough tooth cutting was so great that pinion life could be increased 10 to 20 times by more care in workmanship.

T. A. Jasper, of the A. O. Smith Corp., characterized the research as the finest example on record of logical investigation of fatigue phenomena and factors. A. B. Peterson, of the Westinghouse Electric & Mfg. Co., stated that in a number of different practical cases of stress concentration in machine parts fatigue tests have corroborated calculations of stress concentration factors. Dr. L. B. Tuckerman, Bureau of Standards, referring to the short duration of many of the axle life tests (equivalent to about 30 mi. driving in low gear), emphasized the controlling influence on these fatigue failures of occasional cycles of greatly increased stress occurring in the course of cycles of moderate stress. Drawing on Bureau of Standards experience, he confirmed the authors' view that mechanical factors often have greater influence than steel quality. Designs with sharp reentrant angles, rough projections and sharp fins are common, and usually after a fatigue failure has been provoked by these stress raisers the designer complains that the material was not good enough.

Fatigue of metals

Other developments in fatigue of metals were recorded by a committee report and two papers. The committee of which H. F. Moore (University of Illinois) is chairman compiled and presented a series of notes and recommended practices for making fatigue tests with the rotating-beam machine, including descriptions of the machine and specimens as well as test procedure and methods of recording data. In cooperation with the X-ray subcommittee of the committee on metallography, Professor Moore's committee is sponsoring tests at the Carnegie Institute on the use of the X-ray as a means of detecting impending fatigue failure. Specimens of an aluminum alloy and of silicon steel have been examined. So far, line widening from repeated stresses, as shown on photograms, has proved quite insensitive as a measure of the progress of fatigue. For the silicon steel (and not for the aluminum) peripheral widening of diffraction spots on a stationary film, however, shows promise.

A new type of apparatus, known as the rotating-wire-arc fatigue machine, was described by J. N. Kenyon (Columbia University). Its field of application is in testing small-diameter wire, as is used in cable manufacture and subjected to pulsating stresses. The specimen, hanging in an arc between two bearings, is rotated by an electric motor attached to one end of the wire. The bearing holding the opposite end may be adjusted horizontally, giving different radii of curvature. Stress computations are based on measurements of the horizontal chord.

Fatigue tests of metals at low temperatures were reported by W. D. Boone and H. B. Wishart (University of Illinois). Such tests are uncommon but are important to both the railway and aviation industries. Cantilever fatigue machines run by 12,000-r.p.m. motors were used in the tests, which were performed at Wright Field, Dayton, Ohio. Both notched and unnotched specimens were used. Temperatures were +80, +10, —20, —40 and —50 deg. F. All of the metals tested—duralumin, brass, gray cast iron, meehanite, cold-drawn steel and rail steel—showed an increase in endurance limit, with decreasing temperature, although the cold-drawn steel did not increase below —20 deg. F. The stress-concentration factor as determined by the ratio of the endurance limits of the unnotched to the notched specimens showed no consistant change with decreasing temperatures.

Testing methods discussed

New testing methods and discussions of old methods were the subject of a number of papers as well as committee reports. Some are noted here.

Measurement of particle size distribution by turbidimeter (now commonly used for cement) and by air-analyzer was studied by R. N. Traxler and L. A. H. Baum, of the Barber Asphalt Co., Maurer, N. J. They concluded that the color and other optical properties of the particular material affect the turbidity deterioriations, and turbidity is not proportional to surface area. A synthetic powder gave turbidity results that disagreed with the known composition.

Difficulties of hardness testing of light metals were discussed by R. L. Templin, of the Aluminum Company of America, New Kensington, Pa. None of the ex-

isting tests was found satisfactory in general application; "in general, experience has shown the tension test to be quite preferable to any of the hardness tests when the form and size of product permit of its use."

A new hardness tester was described by W. M. Paterson, of the Tinius Olsen Testing Machine Co., Philadelphia, using a diamond cone point of 100-deg. angle with point of 136 deg., struck by a 320-g. hammer of adjustable drop height; the penetration of the cone is measured directly by a dial gage.

H. C. Mann, of Watertown Arsenal, discussing "The Relation between Tension Static and Dynamic Tests," brought forward the view that a given metal possesses a fixed potential energy, and by taking this into the calculation undertook to show how dynamic test results accord with static strengths.

Yield-strength measurement

A general discussion of yield strength was the theme of one session of the metals groups of the society. Opening with a review by L. H. Fry of the entrance of yield-point requirements into steel specifications, the non-existence of typical yield in non-ferrous metals was pointed out. R. L. Templin suggested that for ferrous metals the elastic limit be defined as a fixed ratio of yield strength. Prof. J. B. Kommers, comparing various yield criteria, said that the user engineer should determine which is to be used for a particular material. Prof. M. F. Sayre raised question as to the relation between yield strength and creep. W. M. Kenyon and Prof. M. O. Withey mentioned the difficulties in yield measurement arising from imperfections in specimen and machine; speed of testing machine has much influence, especially in screw-and-lever types. Dr. L. B. Tuckerman referred the problem of the significance of yield to the question "What happens in the structure?", especially since the stress distirbution there is far less uniform than in the testing machine specimen. No single yield strength can be defined for all kinds of material, he asserted, and for safe design the designer must know his material.

Steel and iron

Some important specification changes were made in the field of steel, wrought and cast iron, but only one research paper was presented except for those dealing with creep and fatigue phenomena.

What happens when a thick plate is bent cold was studied by C. H. Gibbons, of the Baldwin-Southwark Corp., Philadelphia, who reported that the metal in the outer fibers was changed so that the normal stress-strain curve with sharply defined yield became a curved line without yield. Stress-relieving at 1200 deg. restored the normal curve, however. The plate, a low-carbon plate 3½ in. thick bent to about 20-in. radius, was dished inward along the middle line by the bending and was reduced in thickness more at the edges than in the middle, an effect due to the pinching effect resulting from roll deflection, as was pointed out in discussion.

Committee A-1 on steel reported progress in many directions. Some eight specifications were approved for submission to the American Standards Association. A new tentative specification was proposed for axle-steel concrete reinforcement bars. This steel comes in three grades, with yield points of 33,000, 40,000 and 50,000 lb. per sq. in. respectively and corresponding ultimate strengths. The reinforcing bar subcommittee is developing specification requirements covering fabricated concrete reinforcement material.

Several developments of interest to the welding field were recorded. The standard specification for mild steel plates (A10-34) was added to the list covering steels suitable for fusion welding. A recommended practice for the conditioning of rolled steel surfaces by welding was approved for insertion in the bridge and building steel specifications. The effect of carbon and manganese on weldability will continue under study.

Revisions of the specifications for structural nickel steel and structural silicon steel are being studied, and specification requirements for high-strength rivet steel are under development.

Individual specifications for steel castings for various uses have been drafted to replace a consolidated specification. Tube and forged pipe flange specifications were approved, as well as a revised track bolt specification, on which agreement was obtained with manufacturer and user organizations.

Revised specifications for round-hole screens for coarse aggregates require staggered or triangular spacing of the holes.

The first standards of the society for metal platings on steel, covering zinc, cadmium, and nickel and chromium, were recommended for advancement to standard. Revisions in fence wire specifications were proposed, and three former specifications for fence and for testing galvanized wire were withdrawn.

In the stainless steel field, tentative specifications were proposed for soft corrosion-resisting chromium-nickel steel and for chromium steel castings of 12, 19 and 28 per cent Cr. A caution against use of oxyacetylene repairs was removed from these specifications, however, on presentation of evidence that the supposed objections do not exist.

Two new tentative specifications for wrought-iron sheets were adopted, covering uncoated and galvanized sheets of 8 to 28 gage for such uses as roofing, siding, and for corrugating and other moderate forming requirements including culvert material.

Revised tentative specifications for gray-iron castings were adopted. Revision was based upon considerable investigative work in correlating transverse and tension tests. The separately cast tension bar test is eliminated in the revised specification and a new set of values is substituted for the values for the transverse test.

Preservative coatings

The subcommittee on underground pipe protection reported that it was not ready to submit specifications for bituminous primary coatings. The work has been delayed mainly for lack of a satisfactory test for adhesion and a method of testing the durability of these and other paint coatings. The committee presented a statement of principles of testing paints and combinations of paints on steel panels with particular reference to submerged conditions. The principles cover the preparation of surface, application of paint, and test methods.

Exhibits

Some twenty companies exhibited various materials testing apparatus and in addition several of the committees, notably those on corrosion of non-ferrous metals, on die castings, on metallography, and on petroleum products and lubricants had extensive displays. The Universities of Illinois and Michigan also exhibited some of the apparatus developed in their laboratories, among the exhibits of the latter being an acoustical stroboscope useful for locating noises in machinery. Michigan State College exhibited a globe photometer for measuring light intensities. Strain meters, contraction joint meters and resistance thermometers developed by R. F. Carlson featured a display loaned by the Bureau of Reclamation.

Vassar elected president

H. S. Vassar, of the Public Service Corp. of New Jersey, was elected president of the society, succeeding Dr. Hermann von Schrenk. Prof. A. E. White, of the University of Michigan, was elected vice-president. New members of the executive committee include: H. H. Morgan, of the Robert W. Hunt Co.; R. C. Hallett, National Lead Co.; N. L. Mochel, Westinghouse Elec. & Mfg. Co.; W. R. Webster, Bridgeport Brass Co.; and W. H. Graves, Packard Motor Car Co. The society will hold a spring meeting at Pittsburgh, March 4, 1936, while its summer meeting next year will be at Atlantic City.

Award of the Dudley Medal for the best paper of the past year was made to C. A. Hogentogler and E. A. Willis, of the U. S. Bureau of Public Roads, for a paper entitled "Subgrade Soil-Testing Methods," presented last June.

Next week, *specification and research developments in cement, concrete, timber, brick and road materials will be reported.*

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July 4, 1935

Going Back to Work

REVIVED ACTIVITY in the study of materials and their problems of selection and use was evident in last week's Detroit meeting of the American Society for Testing Materials even more strongly than in the meeting of a year ago. The revival is a sign of fresh constructive purpose among industrial men, a new recognition of the fact that progress both in business results and in technical achievement follows upon improvement derived from research. It was inevitable that the difficulties created by the abnormal conditions and financial pressure of the past few years would curtail research, but fortunately even the modest revival that has taken place was able to reinstate improvement study in its rightful position. An acceleration of the trend may be expected, especially now that the end of the NRA system makes it necessary for every industrial unit to be in the soundest and strongest position to compete, with the help of efficient products and methods. Industry, it appears, is going back to work.

Not Efficient

AN INSTRUCTIVE REMINDER of the interdependence of such related agencies as the road and vehicle was given by a symposium discussion at the Detroit meeting. The facts brought out left the clear impression that road planning, for example, can hardly go ahead with assurance of being on the right course unless it considers not only the present vehicle but also its further development. Whether for the automobile of today or for that of the future, however, our present highway transportation system is not efficient, Prof. John S. Worley declared, and no one who has given thought to the subject will challenge his statement. The essential reasons for the inadequacy and inefficiency of the existing highway system are picturesqely summed up in Mr. Worley's characterization of present roads as *neighborhood roads*. Without undertaking to specify the weaknesses reflected in this designation, we may point out that improvement of the highway transportation system necessarily requires the creation of a coordinated network of through and local roads. The development of such a network is a task of formidable size, as to both planning and execution. Probably all of the next quarter century will be required to accomplish it, but there is no doubt of its necessity nor of the fact that it will come about.

The Pork Barrel Again?

MEANS TO PLACE a new federal building in every Congressional district in the country are provided by the public buildings appropriation just voted by Congress. There is no evidence that the buildings are needed, but they will probably prove convenient especially in the next election. Since virtually all other government development operations were made dependent on the works program, and discussion over the works bill showed unmistakably that public buildings were intended to be included, the fact that a building appropriation was enacted separate from the works program is a natural cause for surprise. Does it mean that Congress is still practicing its old-time pork-barrel methods? We thought they had been done away with, but the buildings bill suggests that they survive.

What Price Salmon?

FISHWAYS at the Bonneville Dam are to cost $3,200,000. That is, this is the figure that now has the approval of Washington officials after the original $800,000 estimate of the engineers repeatedly was extended and expanded as the result of pressure from fishery interests. However, since the present plans have been formally approved, the fishery experts have asked for additional changes that would still further increase the cost. There comes a time when the worm will turn. Reasonable expenditure for fishways would not be opposed, but when there is still clamor for more after the ante has been raised beyond three million dollars the fishery people must expect opposition. Do fishery experts know enough about salmon habits to guarantee returns on this outlay of cash? Would corresponding expenditure for fish hatcheries in Alaska or elsewhere be a better investment? Altogether about ten dams are proposed for complete development of the Columbia River; are all of these to get $3,000,000 fishways? And, if so, what return will there be on this investment if the salmon decide they do not like the new regimen of the stream after it has become largely a succession of reservoirs? Salmon used to run up the Sacramento River, but salmon runs in that stream now have practically ceased, although no dam ever has been built across it. Perhaps a moderate and reasonable expenditure for fishways on the Columbia River dams is all that is warranted.

Fatigue Studies and Structures

WHEN THE CIVIL ENGINEER contemplates the results of the remarkable studies of fatigue carried out within the last two decades and still going ahead at accelerated rate, he often thinks of them as significant to the mechanical engineer alone but without application to static structures. In the end, since most civil engineering work is concerned with structures of the latter type, he is apt to dismiss the subject as lying outside the range of his concern. But in the light of the understanding of fatigue causation that has developed in recent years such a conclusion is seen to be faulty. It has been shown that fatigue failure originates at points of high local concentration of stress, and accordingly the ultimate result of fatigue investigations is to reveal the conditions under which large stress concentrations occur and how members of machines or structures may be designed to avoid them. Now it needs no argument to demonstrate that stress concentration is significant not only in machines but also in static structures; in fact the efficiency of civil engineering design rests essentially on the ability to distribute stresses and avoid their concentration. It is true that a great number of repetitions of moving-load stress, such as will compare with a typical series of fatigue cycles, occurs only in rare cases—among them, perhaps, the elevated railroad structures of large cities with their constant succession of trains carried through many decades; but the same stress concentrations that lead to

trouble under repetition of load are also harmful in purely static conditions. Discovery and elimination of points of stress concentration are, therefore, the first principles of progress in structural design. If this fact be given due consideration by the civil engineer, he will probably find that fatigue research is fully as significant to him as to his machine-building colleague.

A Half-Year Summary

THIS WEEK it is just six months since the works bill was announced. No construction has yet been begun, not a man has been put to work. Winter will see a bare start on the work. Of course, long before that the state emergency relief activities will be taken over, but this means no new employment.

Back in 1933 everyone thought that the PWA was inexcusably slow, yet in two months it did more than the administration of the works bill has accomplished in six months. Why the delay? Is it due to official ineptitude and procrastination, or to frequent change of plan arising from confusion and gross miscalculation, or to a deliberate wish to make political capital? Whatever the cause, certain it is that in the course of the delay the principles and objectives laid down in the President's message in January, which was the means of selling the program to the country, have been largely forgotten or disavowed.

Thus we witness today the most extraordinary spectacle of confusion and inaction in the entire record of recovery efforts. In point of fact the present one is not a recovery effort at all but a pure relief-labor plan in which the needs of recovery are being disregarded.

Looking ahead, what is the program likely to accomplish? It is a reasonable prediction that it will fail in its essential purpose. The purpose, of course, is to produce employment that will stay, and what this means is rather clear from some current figures. The durable-goods industries are still at little over half their pre-depression volume, so the National Industrial Conference Board has just found; and as the Commerce Department states this week, construction is "lowest in the scale of major industries." To take men off relief and put them back to work, then, means to put them back into these industries. But this cannot be done by a program that ignores both the construction and the supply industries and threatens to put them farther out of business.

Even as a CWA campaign the new works program promises to fail. Relief-work activities of the last eighteen months have absorbed most of the ready-to-hand improvement jobs available. Thus, there is real risk that the program will not find a sufficient amount of useful work outside the normal budgetary field. Should the program, like the CWA campaign, take up work of normal kind and actually put men out of employment, it would be both a calamity for the nation and a discredit to its government.

Meanwhile the program is changing character daily, under the dictates of necessity and apparently also political expediency. In the process of change the CWA tendencies will probably lose ground; this will mean increased recovery effect, but also more confusion, more waste, and more bewilderment of cooperating authorities. The confusion of the highway program is an example.

As those charged with allotting the funds come face to face with reality, it is inevitable that they will shift their course. This is the brighter side of the picture. A shift has already been made in grade-crossing work, and others are believed imminent. In these readjustments there remains hope for recovery.

For Better or For Worse?

THE WAGNER BILL, passed by Congress, is about to become law. Its intended purpose is to promote industrial peace through establishing equality in collective bargaining between employers and employees. Unfortunately, however, this purpose is nullified by one-sided and unfair provisions.

Industrial peace or settlement of strife of any kind depends upon recognition of the rights of both parties—and of the responsibilities accompanying those rights. Such recognition is entirely lacking in the Wagner Act. Incorporating, as it does, all the objectionable features that have been challenged and criticized during the past two years, the act has little chance of promoting the peace for which it is intended.

In brief, the act guarantees the right to labor to bargain collectively through representatives of its own choosing. To uphold this guarantee, the act specifically names certain practices which shall be considered unfair. Here is the act's chief weakness, for all unfair practices are assumed to be performed by employers only—labor, by unavoidable implication, is always in the right and has no unfair practices to be curbed. In addition, the right to strike is upheld, regardless of cause.

An independent board of three members is established to administer the act. Upon complaint, presumably by labor only, this board has the power to investigate and then make rulings, subject to court appeal. But here further inequity appears. The employer can be compelled to abide by provisions of the Wagner Act, but there are no means available for preventing labor from disregarding a decision it may consider unfavorable. It is inevitable that such a law will incite more strikes.

Just how the act affects construction is uncertain. Construction is not in nor does it affect interstate commerce, and therefore may not come under the act. If it should, however, uncertainty as to the unit of collective bargaining is a complication. The board has the right to determine whether "the employer unit, the craft unit, the plant unit or subdivision thereof" shall constitute the basis for bargaining. Fair and representative units of labor will be difficult to obtain.

In any event the Wagner Act can do little toward establishing better labor relations and solving the perplexing labor problems of construction. The solution of inter-labor difficulties—elimination of the racketeering and exploiting labor leader, settlement of the vexing jurisdictional dispute—is of far more importance to the welfare of construction and construction labor than is the establishment of collective-bargaining methods.

Quite as was said in these pages a year ago of its predecessor bill (May 31, 1934, p. 719), the present act is powerless to bring progress toward industrial peace because of its many shortcomings and defects. Provision for direct settlement of industrial disputes by compulsory arbitration and governmental supervision of labor organizations are essential requirements of any plan to preserve industrial peace. The Wagner Act wholly fails to provide them. In place of making labor relations better, it gives every promise of making them worse, unless early action by the Supreme Court should remove the act from the statute books.

CURRENT NEWS

Use of Relief Funds Proposed for More Feeder Roads

Washington Correspondence

IN SHAPING its policy on highways under the relief-works program, the Administration requires that a larger proportion of state allotments be spent for feeder road construction than the statutory minimum of 25 per cent. President Roosevelt has had two conferences during the past week with Harry L. Hopkins, Works Progress Administrator, and with Thomas H. MacDonald, chief, Bureau of Public Roads, in which this proposal was discussed.

The percentage may be raised from 25 to 35 per cent to meet the demand of farm organizations for more farm-to-market roads. This would absorb $70,000,000 of the $200,000,000 so far allotted for highway construction from relief-works appropriation. When the bill was in Congress farm organizations demanded $300,000,000 for feeder roads and since then have been insistent that the Administration raise the amount spent for this purpose over the statutory percentage.

The new proposal would not be very significant if the cost of highway construction under the relief-works program is limited to $1,400 per man employed as, at best, this permits little more than grading and draining. Committing such a large proportion to feeder roads would remain as a handicap, however, if the Administration adopts the Shirley plan to permit states to pool relief-works money with all other funds available for road construction, on the condition that they will employ from relief rolls the maximum that would be employed by applying the $1,400 man-year rule to the relief-works allotment.

Troubles in Georgia

Notified by Secretary of Agriculture Wallace that the Bureau of Public Roads will not approve any more federal highway funds for Georgia until an adequate administrative and engineering organization is established, the state highway board replied that the state "refuses to be starved into submission."

The present situation is essentially political as trouble is afoot at every point of contact between the federal government and Governor Talmadge's administration. Ordinarily Georgia would be entitled to receive about $19,000,000 in federal funds during the next twelve months. Secretary Wallace informed W. E. Wilburn, chairman of the highway board, that the Department of Agriculture will determine for itself whether steps which may be taken to meet specified requirements are satisfactory, and that no approval will be given either to further highway programs or to new projects in Georgia until the Department finds that such requirements are met. Federal participation will continue on projects now under construction only so long as engineering supervision by the state is satisfactory.

Little Miami River Project Disapproved by Engineers

Improvement of the Little Miami River for any purpose was held to be inadvisable by Major General E. M. Markham, chief of engineers, in his report to Congress.

The report points out that any effective plans for flood control in the Little Miami Basin, in Ohio, would be much greater than the benefits to be derived and that the location of reservoirs for the control of Mississippi River floods would be ineffective. The report also points out that there are no hydroelectric sites of merit and that there is no demand which would justify improvement for navigation and that the government could not undertake any improvement for navigation or flood control.

A plan which was developed but not recommended by army engineers included one reservoir to be operated for flood control and two reservoirs for power development and flood control combined. This would have cost about $11,740,000, it was estimated, and it was held that the benefit to be derived would not justify this expense.

Engineers Staff Expected At Passamaquoddy

Portland, Maine, June 26.—Lieut. R. B. Lord and D. J. Leehey, aides of Major Philip B. Fleming, of the Passamaquoddy tidal power project, reported that they would leave for Eastport today, to open offices there. A staff of 30 or 40 men, mostly clerical help, is expected to reach Eastport within the next three or four days.

Fraud Indictment Dismissed In Texas Irrigation Case

Dismissal by Justice Jesse C. Adkins in the Supreme Court of the District of Columbia of an indictment returned March 21 by a special grand jury clears Maj. Charles R. Olberg and Perry A. Welty, former PWA engineers, and others, of charges of conspiracy to defraud the government in conjunction with an application made by the Willacy County (Texas) Water Control and Improvement District No. 1 for a combined loan and grant of $4,853,000.

The object of the alleged conspiracy was to bring about rejection by PWA of plans submitted by the Willacy District for construction of the irrigation project by means of a gravity and open canal system and to obtain approval instead for a pipe pressure system on specifications that would confine bidding, for all practical purposes, to contractors who were to use redwood piping. The indictment alleged as part of the conspiracy that William A. Harding, a director of the Willacy District, offered Maj. Olberg a position as consulting engineer on the project for the purpose of using his influence to bring about approval of the pipe system in which redwood would be used.

In asking for dismissal of the indictment the defendants' counsel filed a demurrer protesting the indictment as defective because it charged two conspiracies, one entered into by all the defendants and the other by only a few of them. The court expressed the conclusion that the indictment did attempt to charge two conspiracies and that "it is very doubtful whether either of the separate charges sufficiently describe the conspiracy to defraud the United States."

Relief Works Funds Promise More Public Works Than First Estimated

(Washington Correspondence)

RELIEF WORKS ALLOTMENTS approved by President Roosevelt to June 29 total $1,879,364,114. Allotments for construction projects of $1,003,386,219 represent 53 per cent of this total. For the purpose of this separation, allotments made for the Forest Service, Soil Conservation Service, Civilian Conservation Corps and the Resettlement Administration are classified as non-construction items although all of them include a considerable volume of light construction. On the other hand, the allocation of $50,000,000 for rural electrification is considered as a construction item although it is debatable whether it is properly so classified. The sums set up for rural electrification, low-cost housing, highway construction and grade-crossing elimination constitute allocations against which specific allotments will be made as individual projects are approved. The allocation of $50,000,000 for the National Youth Administration represents the probable expense of one year's operation of the organization created for the purpose of training young persons for industrial, technical and professional employment and finding employment for them in private industry.

Public works not to be subordinated

Relief works projects developed by the Works Progress Administration will claim a large proportion of the $4,000,000,000 work relief appropriation from now on but, taking into consideration the large allotments already made for heavy construction, the expectation is that public works will not be subordinated to the extent that recent expressions of policy by President Roosevelt and Administrator Hopkins imply. It has been pointed out that while rigid application of the policy limiting the cost of a project to $1,140 per man-year would curtail severely the character and quality of public construction done, the low average rate of pay—$50 a month, $600 a year—leaves $540 for indirect labor and materials, or a slice of $1,892,000,000 from the $4,-

000,000,000 fund. The combined purchases of materials for PWA (to date), CWA and the emergency work program carried on by FERA subsequent to the termination of CWA totaled only $1,010,000,000. PWA expenditures for materials will probably be increased by about $200,000,000 but even then the new relief works program exceeds all former figures. In so far as comparison with CWA is concerned the new program also seems to be the better. The CWA program involved an expenditure for materials of $115,000,000, or 13 per cent of the $900,000,000 spent to provide quick employment for 4,000,000,000 men for 18 weeks. This is much less than the $540 per man, or 47 per cent, that will be spent for materials in the relief works program, even if the $1,140 man-year rule were to be strictly applied.

Allotments to Hopkins

Initial allotments for the Works Progress Administration totalling $142,245,275 are expected to employ 169,900 persons on projects costing an average of $812 per man. Allotment of $10,501,346 to Alabama and $38,162,973 to Indiana will start the work program going. Indiana is representative of states in which cost of relief work is high, and Alabama of states where it is low. An allotment of $10,556,603 will be spent in Georgia where direct relief was "federalized" several weeks ago and where the PWA program was blocked by Gov. Talmadge.

The works programs developed by New York City and Washington, D. C. will be launched with allotments of $81,007,310 and $2,017,043 respectively. Three per cent is allowed for administrative expenses.

Bids for Alcova Dam Called July 15 at Casper

Bids for the construction of the Alcova dam on the Casper-Alcova project will be received by the Bureau of Reclamation at Casper, Wyo., on July 15. Construction of the dam, postponed several times, is made possible by a recent allotment of $10,000,000 from the public works fund to the Bureau of Reclamation. The entire project contemplates the construction of Seminoe dam and power plant, Alcova dam on the North Platte River, and canals.

The Alcova dam will require over 1,000,000 cu.yd. of rolled clay, sand and gravel fill, and 388,000 cu.yd. of rock fill for the downstream portion of the embankment. The top of the embankment will be about 250 ft. above lowest part of the foundation.

In the recent approved allocations of funds the $11,360,250 to New York City for construction of the Ward's Island sewage disposal plant is one of the largest. Recent non-federal allotments totaling about $20,000,000, in which the Ward's Island plant is included, were divided approximately as follows: sewers and disposal plants, $12,000,000; schools, $5,600,000; bridges, $500,000; waterworks, $350,000; irrigation and flood control, $116,000. Among the allotments for sewers were $335,700 and $263,000 for Webster Groves, Mo., and New Brunswick, N. J., respectively. A bridge over the Calumet River in Chicago received $472,500, and for development of a recreation park in Allegheny County, Pa., $347,000 was allotted.

Washington Highlights

By Paul Wooton

A lot of carefully planned white collar surveys are going into Mr. Hopkin's ash can because they cannot be conducted for $1,100 per man. If any are attempted at that rate, economists believe, it will mean more worthless statistics and more worthless investigations of the type produced by the old CWA. Experience has shown that not to exceed 50 per cent of untrained workers can be used to advantage in these economic studies. The necessary administrative heads, plus fifty per cent of trained and experienced workers, plus the necessary travel money, run the expense of any properly conducted survey considerably beyond the limits for expenditures fixed by Mr. Hopkins.

Works program allotments approved July 1, include $69,985,000 for the Public Works Administration for low cost housing and slum clearance, and $91,000,000 for rural rehabilitation and relief in stricken agricultural areas.

Direct appeals to the President are being made by Western Congressmen urging that a reclamation program be financed with relief work funds. A soil conservation program that will retire as much land as the adjustment program is being planned. To aid in preventing erosion, inducements will be offered by the government to farmers who will plant parts of their farms in grass and trees.

Washington, July 2, 1935.

McLaughlin Aerial Surveys Photo

HUDSON RIVER BRIDGE IN RIP VAN WINKLE COUNTRY OPENED

The new highway crossing of the Hudson River between Hudson and Catskill, N. Y., known as the Rip van Winkle Bridge, was opened to traffic on July 2. Located some 25 miles south of Albany, the new structure, which cost about $2,000,000, was built under the direction of the New York State Bridge Authority, a division of the state department of public works, which also operates the Mid-Hudson Bridge at Poughkeepsie.

As shown in the view, taken from above Catskill on the west bank of the river, the bridge crosses a back channel and an island by means of a steel-truss viaduct and the main channel by a through-cantilever structure. The total length of the bridge is 5,040 ft., the main channel span is 800 ft., and the anchor arms are 400 ft. The ten deck-truss spans are about 330 ft. each. A 30-ft. roadway is provided. Underclearance for ships is 142 ft.

Construction started in the summer of 1933, on plans prepared by Glenn B. Woodruff, then a consulting engineer and now engineer of design on the San Francisco-Oakland Bridge. The general contractor was the Frederick Snare Corp., which sublet the steel erection and paving to Harris Structural Steel and Corbetta Bros., respectively. All work was under supervision of Frederick Stuart Greene, state superintendent of public works.

Work Begun on Cherry Creek Dam Near Denver, Colo.

A dam to control the waters of Cherry Creek which recently swept through Denver causing extensive damage and carrying away about 16,000 cu. yd. of riprapping, has been started near Sullivan, Colo.

This new dam, which is to cost about $800,000, is being built by the PWA and is designed to act as a check dam for flood waters in the creek. The dam, which is to be made of earth and riprapped, will be 3,600 ft. long. It is designed to impound 10,000 acre-feet of water. Two spillways are to be constructed in this dam, one to allow Cherry Creek to retain its normal flow and the other to take care of flood water if the dam should be filled to capacity.

The dam is to be 300 ft. wide at the base and 20 ft. wide at the top. Below the center of the dam sheet steel piling is being driven to a depth of 21 ft. to protect the base of the dam from underground water. 1,000,000 cu. ft. of earth is estimated to be needed for completion of the dam. Work is scheduled to be completed by May, 1936.

New Jersey to Participate in Tri-State Pollution Board

A bill providing for the cooperation of New Jersey with New York and Connecticut in a joint board for studying the pollution of New York waters was signed by the governor on July 1.

The bill has met with strong opposition from north Jersey towns. New York state has already passed legislation to permit participation in such a tri-state pollution board, but Connecticut has not.

New Jersey will appoint five representatives to the board which is to make recommendations for the cleaning up of the Hudson and East Rivers, New York Bay, and adjacent waters.

Architects Cooperated in Bourne Bridge Design

Design of the Bourne Bridge, recently awarded first prize for beauty in the class of large bridges, in the annual competition of the American Institute of Steel Construction. (*ENR* June 13, 1935, page 857) was carried out with the cooperation of Cram & Ferguson, architects, working with the engineers, Fay, Spofford & Thorndike. Proper credit to the architectural collaborators was omitted from the news item as published.

Goodrich Made Chief Engineer of American Bridge Company

Charles F. Goodrich has been appointed chief engineer of the American Bridge Co., effective July 1, succeeding Richard Khuen, Jr., who has resigned after more than 41 years of service with the company.

Mr. Goodrich, a native of Manchester, N. H., has been with the American Bridge Co. for 29 years, following his graduation from Dartmouth and the Thayer School of Civil Engineering. He began as draftsman in the Trenton plant, and advanced through the engineering department, being appointed assistant chief engineer in 1933, with headquarters in New York. He will have his headquarters in the Frick Bldg., Pittsburgh.

Announcement has also been made that Chauncey E. Webb has been appointed division engineer in charge of the western division of the company in Chicago.

WHERE GRAND COULEE DAM WILL STORE COLUMBIA RIVER WATERS

The change order, which provides for the construction up to a height of 177 ft. of the complete section for the 475-ft. dam ultimately contemplated, has created new interest in the Grand Coulee project on the Columbia River in Washington. The new order does not call for immediate construction of the power plant. The immediate purpose of the dam is to store water for irrigation in the Columbia Basin. Adequate irrigation storage has long been the hope of the Northwest. The picture shows the west cofferdam under construction, and the long conveyor belt which carries the spoil from the dam site to the dump. A much longer belt conveyor will be used to bring washed gravel from the gravel pit, which is about 1½ miles away. Placing of concrete in the west cofferdam is expected to start about September 1. The east cofferdam is to get under way during low water in the fall.

Chicago Analyzes Rejection of Low Cost Housing Project

Abandonment by the PWA Housing Division of its proposed $12,500,000 West Side low rent housing project in Chicago caused so much damage to the area concerned and caused such widespread disappointment that the Metropolitan Housing Council undertook an intensive examination of the difficulties which were reported. It was desired to learn the nature of the obstacles so as to find practical methods of procedure for the guidance of future housing undertakings.

Basic reasons for the collapse of the West Side project as given by the Council in a letter to Secretary Ickes are as follows:

1. Complete failure of public relations in all respects.
2. Improper scheduling of operations in the installation of the project.
3. Employment of untrained personnel and the use of ineffective techniques.

Chicago has two more projects and major suggestions made to assure completion of a much reduced West Side project as well as the North Side and South Side projects are: organization of an experienced public relations staff; designation of a strong citizens group from each project neighborhood to maintain close contact between official activities and the property owners and occupants of the area; giving precedence to land acquisition activities over administrative and investigational measures; frequent presentation of information to property owners regarding conditions and benefits of the Housing Division's program and progress to date; decentralization of administrative detail from Washington to regional offices, and reorganization of the personnel and techniques to assure effective execution of departmental policies.

The Council believes that the West Side project could be completed in whole or in part and the other two facilitated and safeguarded by the revisions recommended.

Damage to abandoned area

The damages to the area noted above, as found by a committee of the council, which made an exhaustive examination, is stated as follows: "The economic life of the district insofar as it concerns real estate has come to a standstill. Many tenants have moved from the neighborhood in anticipation of property demolition, others have refused to pay rent, mortgages and tax payments have been stopped."

The area suffered from a multiplicity of investigations, twenty or more, by federal housing, federal emergency relief and home owners loan departments as well as state, county and private agencies which aroused suspicion and caused confusion on the part of many people, which added handicaps to the land acquisition negotiations. The difficulties and delays, according to the committee report, have not been caused so much by general holding for excessive prices or concerted action opposition to community housing as by the techniques and methods used and the inadequate popular understanding of the project objective and benefits.

It is generally conceded that housing projects in such blighted areas as those selected in Chicago can only go ahead if and when the Supreme Court passes favorably on the question of the right to exercise eminent domain.

Filter Plant, Bridges and Dam at Austin, Texas Extensively Damaged by Recent Flood

THE HIGH WATER which swept down the Colorado River through Austin, Texas, on June 15, caused considerable damage to engineering structures. Frank W. Chappell, consulting engineer, defines this damage in its major particulars.

"The unique cantilever bridge, known locally as the Montopolis Bridge, which was illustrated in *Engineering News-Record* last week, failed during the recent record flood in the Colorado River. Eye witnesses differ as to the exact cause of the immediate failure, some saying that a six room house struck the bridge and others that it was a large pile of drift wood. At any rate, the water was over the bridge floor, an immense quantity of floating debris was lodged against the stringers and the failure ensued. The trusses some of which are shown in one of the accompanying views are strung out down the river to a distance of five hundred yards. This bridge was a part of state highway No. 71, but no plans for rebuilding have been announced. It is understood that the state highway commission is making representations to Washington with a view to building a permanent structure.

"This flood left a number of very interesting phenomena. The city water and light plants were put out of service, and the light plant is not yet in use. A failure of a retaining wall on the west side of the low-lift pump station wrecked the station and left the plant without circulating water for the turbines. It will require some time to complete the rehabilitation of the plant, but temporary installations have been made with a view to early resumption of service.

"On the municipal dam, of more or less notorious history, most of the superstructure was carried away. A part of the ogee crest was taken off with the piers, lowering the pool level about 3 ft. A small area of the granite facing of the old portion of the dam was removed. The head on the spillway, above the ogee crest, was 24.5 ft. An accumulation of drift was primarily responsible for taking out the superstructure. Water was at about the level of the track seen on the near side of the dam and on the part of the superstructure which remains. Apparently some of the reinforcing steel is holding portions of the concrete against the spillway apron.

Flood higher than in 1900

"The stage of the river during the crest of this rise was reported as 41.7 ft. The State Board of Water Engineers is making an estimate of the discharge of the stream, but has not completed it. It will likely run over 400,000 sec.ft. The flood which wrecked the dam in 1900 had a discharge of 150,000 sec.ft., so it may be seen that the present structure withstood a far greater flood than that which wrecked the old one.

"The best records indicate that the rise of 1869 reached a stage from 1.5 ft. to 3.0 ft. higher than this rise of 1935. There is a good deal of uncertainty about this however, since the lower part of the city has been raised and graded and it is not known just where the old marks might be in respect to present ones. It would seem that there has been no flood in the Colorado River since 1869 which had a discharge as large as this one. The water came mostly from the Llano and Perdenales rivers and there was no great discharge on the upper Colorado or any of its higher tributaries. It therefore would appear that no flood of record approaches the maximum possible for the stream.

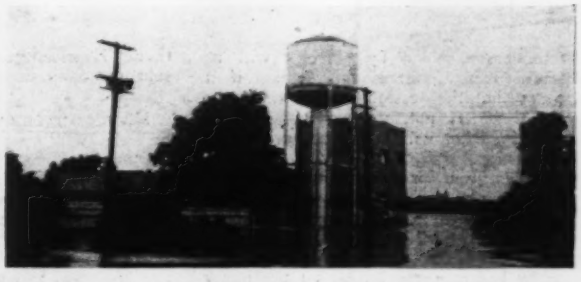
"Hundreds of houses were flooded and many substantial business establishments were wrecked. Most of these were along South Congress Ave., where a bridge and fill increased the velocity of the water. Brick structures were taken out entirely, not even the foundations being left."

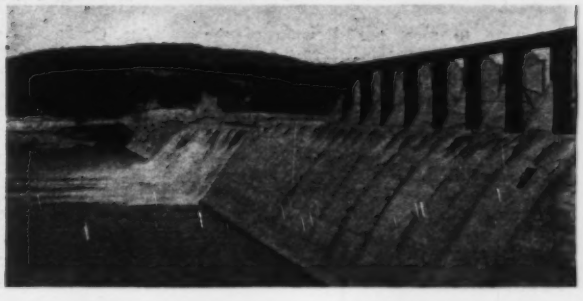
Arizona Formulates Program For Colorado River Development

Arizona's Colorado River Commission, in a report filed with Governor Moeur, has set forth a program for the use of Colorado River water and eventual settlement of the water questions now in dispute. The Parker Dam bill, approved by the U. S. Senate on May 27, authorizing construction of various dams begun under PWA allotments, carried an amendment authorizing a diversion dam at Headgate Rock, 15 mi. below Parker Dam, together with canals for the irrigation of 100,000 acres of the Colorado River Indian Reservation in Arizona. While this bill is expected to dispose of the legal contest over construction of Parker Dam, it does not settle the division of water between Arizona and California. The state attorney-general therefore plans to institute a suit for determination of water rights at the October session of the U. S. Supreme Court. He contends that, while the Boulder Canyon act limits California to 4,400,000 acre-ft. of water per year from the Colorado River, works now in preparation would divert a total of 12,400,000 acre-ft. a year.

Meanwhile the state is seeking to have the federal government build the Parker-Gila project under the Reclamation Act, for the ultimate development of 600,000 acres. The first unit would be on the Yuma Mesa and in the North and South Gila districts. The diversion point would be Imperial Dam, whose other function is to serve the All-American Canal feeding Imperial Valley. Eventually three pumping plants would be required. Parker Dam would furnish power for pumping at an estimate rate of 2.2 mills per kw.-hr. An investment of $23,000,000 would be required to supply the 150,000-acre unit.

FOUR VIEWS of flood damage at Austin, Texas, show remains of old Montopolis bridge, the flooded city filter plant and the municipal dam (no longer used because of silt accumulations) as the flood was passing over and after the water had subsided.





Aggregates Producers Combine To Attack Common Problems

The Mineral Aggregates Institute, members of which are the National Crushed Stone Association, the National Sand and Gravel Association and the National Slag Association, was organized, June 30, in Chicago by the boards of directors of these associations, to consider and act upon matters affecting the common interests of the three member associations. These interests, to be designated by unanimous consent of the governing body of the Institute, include national legislative and governmental relations, freight rate proposals, and others of similar broad nature. An executive secretary and treasurer are to be elected from the paid staff of member associations but others of the six members of the governing board will serve without compensation. In general the Institute will take over from the mineral aggregates code authority such duties as the industry associations may elect to handle, leaving to local or regional organizations matters of economic interest.

Already nearly 40 per cent of sand and gravel production is by non-commercial units, and one of the first steps will be an active campaign against governmental competition. Current factors recognized as conducive to fostering such competition include promotion of low-type roads, the growing use of large trucks for long distance transportation, high freight charges, promotion of portable equipment production to relieve unemployment, and misconception of production costs. It is proposed to oppose these tendencies, and to persuade highway officials that secondary roads need better materials than are too often being used. This activity follows that started by the code authority last January.

A resolution by the combined assembly of the three associations condemned the rules and regulations governing the relief works program on the ground that they were nullifying the original conception of Congress regarding expenditure of the $4,000,000,000 fund.

Plans Made for Federal Law For Silicosis Compensation

Legislation providing for compensation for miners disabled by silicosis will be introduced in Congress this session if it appears that the session will continue for some time. If not, its sponsor, Senator Pope of Idaho, will introduce such a bill next session.

Compensation for miners totally disabled by the respiratory disease would be provided from a fund, 25 per cent of which would be supplied by the federal government, 25 per cent by the states and 50 per cent by the property for which the miner works.

Designed to meet the decision of the Supreme Court in the NRA case concerning the commerce clause of the Constitution, the planned legislation is based on the idea of having the mining states pass their own compulsory compensation laws to get the 25 per cent federal donation. Such state laws will require mines to take out insurance to cover the 50 per cent for which they will be responsible. Its sponsors hope that the preventive measures required in insured mines by the underwriters will help to prevent the disease.

SOCIETY CALENDAR

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, summer meeting, Ocean City, N. J., July 11-13.

INSTITUTE OF TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, at their meeting in Atlanta, Ga., June 24-27, elected the following officers: president, DEAN D. F. ANDERSON, of Tulane; vice-presidents, DEAN S. B. EARLE, Clemson College, and DEAN P. H. DAGGETT, Rutgers University; secretary, PROF. F. L. BISHOP, University of Wyoming; treasurer, W. O. WILEY.

COLORADO CHAPTER of the American Society of Civil Engineers, at a recent meeting, elected the following officers: FRED C. CARSTARPHEN, president; E. B. DEHLER, vice-president; PAUL S. BAILEY, secretary-treasurer.

Brief News

NORFOLK GENERAL CONTRACTORS in a special meeting of more than twenty companies voted to continue the principles of the NRA.

DREDGING OF HARPER'S ISLAND CUTOFF on the Mississippi River near St, Joseph, Mississippi, has already begun. The channel, 2¼ mi. long, will be cut across the Harper's Island in order to straighten the channel of the Mississippi River. The cutoff, when completed, will shorten the length of the Mississippi River by about ten miles.

THE SIXTH LIMITED DIVIDEND HOUSING PROJECT of the seven financed by the PWA was opened to tenants on July 1. It is in St. Louis and is known as Neighborhood Gardens. Consisting of five buildings, it provides 252 apartments. The project yet to be completed is that of the Boylan Realty Co., in Raleigh, N. C.

REPRESENTATIVES of local contractors and subcontractors on June 25th adopted a code of fair trade practices for the Louisville building industry to become effective July 1. Unlike the old NRA construction code, severe penalties were included for infractions. Nineteen general contractors and 41 subcontractors signed the agreement.

MANUFACTURE OF BUILDING BOARD from garbage will soon be started in Berlin, Germany. About 50 per cent of the city's garbage will be consumed by this process. Ferrous materials are to be removed from the garbage by a magnet and fibrous materials such as vegetables and newspapers are used in the manufacture of board which can be sawed and nailed.

AN ORDER TEMPORARILY RESTRAINING the city of Haskell, Tex., from expending $750 for a survey to determine the feasibility of seeking a PWA loan and grant to finance a municipal power plant has been issued by a district court in Abilene. The petition for the injunction was based upon an allegation that the proposed survey would be in violation of a state budget law, which provides that cities shall prepare annual budgets, hold public hearings upon them and restrict expenditures to budget provisions.

Personals

GEORGE E. CRANMER has been appointed manager of parks and improvements for the city of Denver, Col.

EDWIN E. WALL, director of public utilities, St. Louis, Mo., received the honorary degree of doctor of laws from the University of Missouri on June 5.

WILLIAM B. LAMBERT, of Webster Groves, Missouri, who has recently been employed as an appraiser is now working on the Fort Peck Dam in Montana as a field engineer for Frazier-Davis Construction Co. and G. L. Tarlton.

RALPH MOHR, resident engineer of the Rhode Island division of roads and bridges for 14 years, and actively identified in paving work involving the use of sheet asphalt, resigned from his office on July 1. Before the world war he was in charge of the initial survey for the Providence water works development.

N. R. BEAR, regional technician, has assumed administration of the C.C.C. camps engaged in soil erosion work in Ohio, Indiana, Kentucky, and West Virginia, with district headquarters at Zanesville, Ohio.

KENNETH WELTON has been appointed assistant regional director of soil erosion service there.

EDWARD WRIGHT ARMS was awarded an honorary degree of doctor of engineering by Rensselaer Polytechnic Institute at the exercises commemorating the 100th anniversary of the awarding of degrees in engineering and science. Mr. Arms, who was born in 1845, received his degree from Rennselaer in 1869. He has been connected with W. & L. E. Gurley, having entered that firm in 1862.

COMMANDER RALPH D. SPALDING, CEC, U. S. Navy, has been assigned to duty at the Bureau of Yards and Docks, Washington, D. C. Lieut. Commander Fritz C. Nyland has been transferred to Mare Island, and Lieut. Commander Lewis M. Moeller to Pearl Harbor. Lieut. Commander John J. Gromfine has been assigned to duty at Norfolk Navy Yard.

AUBREY WEYMOUTH, chief engineer, Post & McCord, steel erectors, New York City, has been awarded an honorary degree of doctor of engineering by Lehigh University. Mr. Weymouth, who received his C.E. degree from Lehigh in 1894, started his engineering career as draftsman and inspector with the Navy Department at Port Royal, S. C.

ARTHUR WALSH, regional director of the FHA for New Jersey, Pennsylvania and Delaware, has been appointed deputy administrator of the FHA in Washington. He will have charge of home modernization and repairs under Title I of the National Housing Act. Mr. Walsh has been associated with the FHA since April, 1934.

JOHN ENGLAND, Jr., has received the appointment as engineering consultant to the division of applications and information. Mr. England, who was born in Scotland, came to this country in 1905, and has since been engaged in architecture and engineering. From August, 1931, to May, 1935,

he was an inspection engineer with the public works branch, procurement division of the Treasury Department.

W. G. HUXTABLE, who for many years has been district engineer for the Arkansas highway department, has been appointed chief of the St. Francis River Levee Board. Mr. Huxtable succeeds Harry N. Pharr, who has recently been named on the Mississippi River Commission by President Roosevelt.

LEONARD HANSCOMBE SINCLAIR has been appointed to the technical staff of the Division of Applications and Information. Mr. Sinclair received his engineering education at Columbia University and Massachusetts Institute of Technology. In 1903 he joined the staff of the Baltimore & Ohio R.R. and later went to the Bureau of Yards and Docks. Since 1930 he has been special assistant to the Shore Station Development Board of the Navy Department.

Obituary

JOHN J. LICHTER, consulting engineer of St. Louis, Mo., died in Estes Park, Colo., June 14, while on his vacation.

ISAAC HATHAWAY FRANCIS of Philadelphia, Pa., died at his home there on June 26. He was 57 years old. Mr. Francis, who graduated from Cornell University school of engineering in 1901, had been consultant on many important Philadelphia buildings. He was also called in as consultant on the Indianapolis public library and the Department of Justic building in Washington as well as on many other buildings.

ISAAC W. LITCHFIELD, staff engineer of Bemis Industries, Inc., research organization in the building materials and housing field at Boston, Mass., died at Quincy, Mass., on June 24 at the age of 73. He was educated at the Massachusetts Institute of Technology and was active in its affairs for many years as editor of the "Technology Review." Mr. Litchfield was for a time general manager of the Acme Harvester Company, Peoria, Ill.

JAMES C. RUFF, city manager of Staunton, Va., died there June 26 as the result of an injury sustained while playing baseball. Mr. Ruff, who was 45, had received his education in engineering at the Virginia Polytechnic Institute.

ROLAND BRADBURY RAND, civil engineer and contractor of Boston, Mass., died at his home in Weston on June 17 after a short illness. He was 58 years of age, and was a graduate of the Harvard Engineering School. At one time he was engineer of subway construction for the Boston Elevated Railway and the Boston Transit Commission, and later was engaged in the construction of the Army base in Boston.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING CONTRACT awards at $19,429,000 are lower this week and represent only a four-day week due to early closing on account of the Fourth of July holiday. The corresponding week last year totaled $13,536,000. Of this week's total $14,064,000 is for public construction, of which $12,191,000 is state and municipal and $1,873,000 federal. Private awards total $5,365,000. For the corresponding week last year, the private total was $2,014,000.

There has been a slight rise in commercial buildings at $2,411,000, but all other classifications are lower. The sharpest decline has been in industrial buildings, which totaled $1,607,000 against $6,411,000 last week.

The larger awards include a school at Teaneck, N. J., $512,000; one at New Dorp, S. I., N. Y., $669,000; highway work by Missouri, $2,199,000; Schedules 1 and 2 of Ogden Canyon Conduit, Ogden River project, Bureau of Reclamation, $612,000; Manhattan approach and plaza of Midtown Hudson Tunnel, $2,723,000; gas pipe line between Clayton, Wyo., and Bridgeport, Neb., for North Central Gas Co., Casper, Wyo., estimated to cost $1,000,000.

State and municipal bond sales for the week totaled $3,349,000. The President has approved allotments to PWA from the new relief works fund totaling $37,281,000 for non-federal projects and $85,794,000 for federal projects. The new fiscal year starts under the Hayden-Cartwright Act, and the $100,000,000 for 1936 becomes available for highways. The total addition to the new capital statistics for the week is $226,424,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average July 1934	Prev. 4 Weeks	Week July 4 1935
Federal Government	$10,224	$6,704	$1,873
State and municipal	14,816	11,161	12,191
Total public	$25,040	$17,865	$14,064
Total private	4,450	9,675	5,365
Week's total	$29,490	$27,540	$19,429
Cumulative to date:			
1934...$726,510,000	1935...$676,700,000		

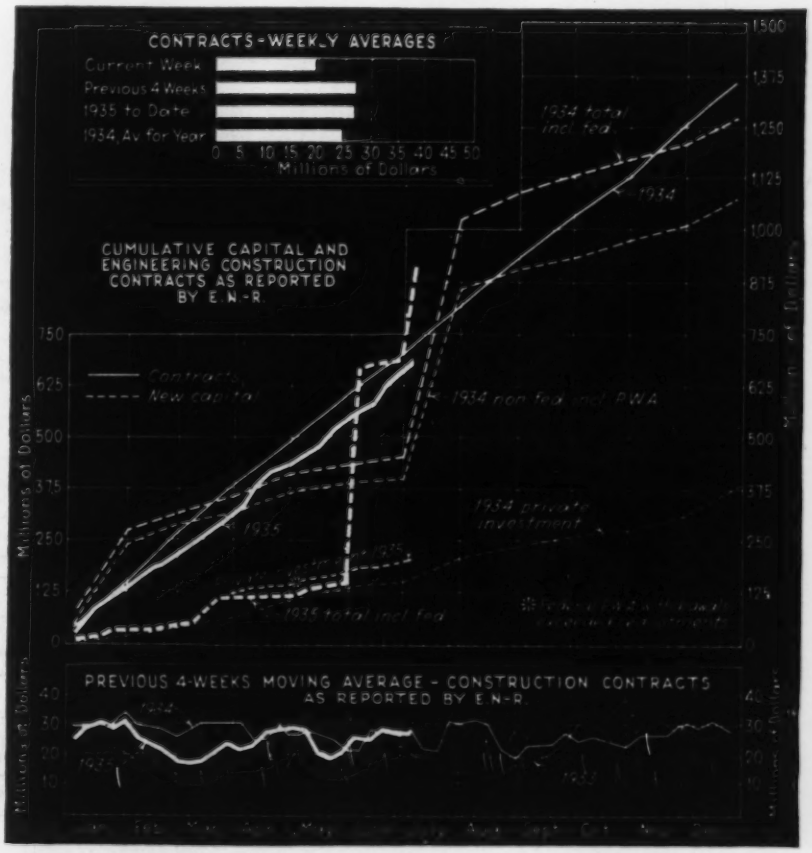
NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1935	Week July 4	Cumulative
State and municipal	$3,349	$200,939
PWA allotments, S&M	37,281*	—14,755
Highway Funds, 1936 Hayden-Cartwright	100,000	100,000
RFC loans, S&M	.....	84
Corporate issues	.....	.....
PWA allotments, private	.....	8,059
Total, Non-Federal	$140,630	$294,327
PWA allotments, Federal Constr.	85,794*	617,735
Total new capital	$226,424	$912,062
Cumulative to date:		
1934...$840,504,000	1935...$912,062,000	

*Approved by President, from new relief works fund. Allotted to PWA. Includes $21,353,000 grants of 45% of estimated cost of non-federal work.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.



BUSINESS SIDE OF CONSTRUCTION

Private Construction Increases Gain June Awards Higher Than May

THE first six months of 1935 closed with private engineering construction registering a 48 per cent gain over the same period last year while federal contracts lagged 35 per cent, and state and municipal 12 per cent behind last year's rate. The weighted average for public construction is a lag of 20 per cent behind the first half of last year. In dollar value, total engineering construction for first six months is $657,271,000 in 1935 compared with $712,974,000 in 1934; federal awards, $137,694,000 compared with $210,468,000 in 1934, total public, $468,404,000 compared with $585,116,000 in 1934 and private awards $188,867,000 in 1935 compared with $127,858,000.

Geographically this lag of 8 per cent in the national total is distributed as follows: New England, 11 per cent below last year at the end of the first 6 months, Middle Atlantic, 27 per cent ahead, South, 21 per cent below, Middle West, 11 per cent ahead, West of Mississippi, 32 per cent behind and Far West, 14 per cent below 1934.

Highway construction shows a 33 per cent lag compared with last year while a substantial gain is recorded in buildings, public buildings, 24 per cent ahead of the first 6 months in 1934, commercial buildings, 4 per cent, and industrial buildings, 92 per cent gain over the first half of last year.

June awards

June awards were heavier than the May volume in both public and private construction. The June total of $110,161,000 for 4 weeks compares with the May 5-week total of $122,827,000. By average per week, June at $27,540,000 compares with May at $24,565,000 for total awards, and $9,675,000 for private construction compared with $8,336,000 in May. Public awards at $17,865,000 per week in June compare with $16,229,000 in May.

In June, street and road awards dropped 20 per cent below May, while public building awards were 86 per cent higher and commercial buildings were 57 per cent higher than in May. Industrial buildings dropped 17 per cent below the record high volume of last month but are 264 per cent higher than June last year.

The June gains over May are distributed geographically, the largest in New England, 143 per cent; 15 per cent in Middle Atlantic; 13 per cent in South; 3 per cent in West of Mississippi; 10 per cent, Far West; while Middle West territory drops 32 per cent below the record high volume recorded in May.

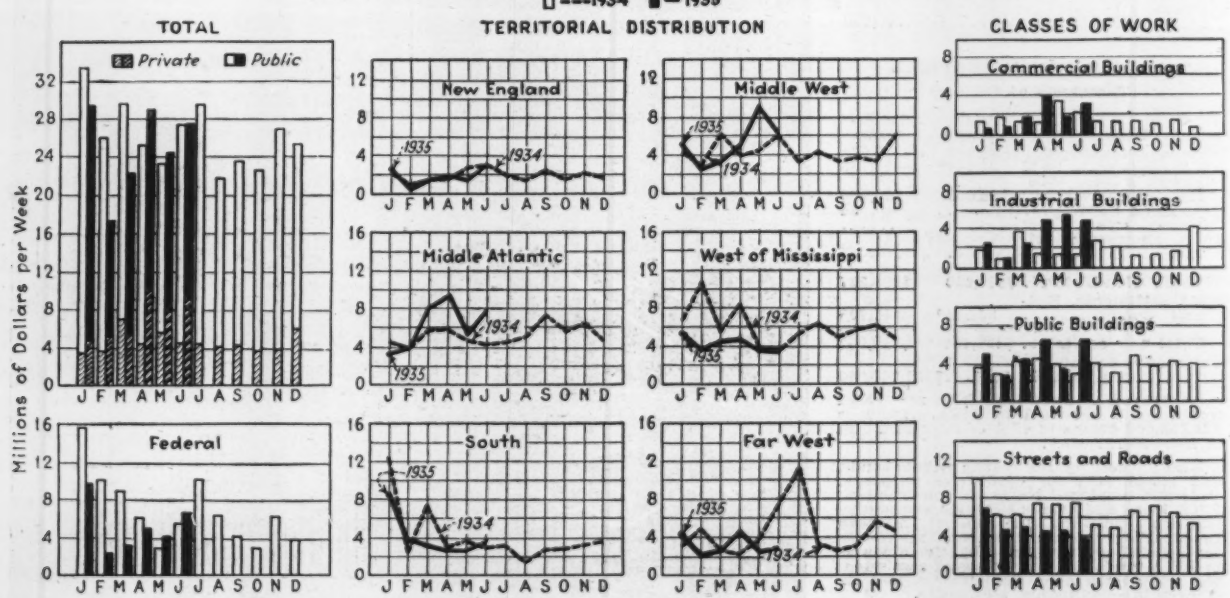
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN JUNE, 1935

Four Weeks—Thousands of Dollars—(000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States June 1935	United States Six Months 1935	United States Six Months 1934	Canada
Public Works										
Waterworks	860	426	2	486	1,842	427	4,043	35,561	32,143	50
Sewers	350	641	238	2,191	1,310	360	5,090	33,448	28,087	57
Bridges, public	91	2,625	571	1,588	1,183	604	6,662	34,652	49,535	95
Earthwork and waterways	3,987	261	1,173	1,038	557	3,949	10,965	86,342	149,015	151
Streets and roads	1,547	1,650	3,499	2,848	3,155	2,163	14,862	128,615	192,184	2,803
Buildings public	817	12,528	2,171	5,400	3,162	1,677	25,755	123,416	99,185	410
Unclassified public	75	1,670	173	159	149	1,858	4,084	26,370	34,967	5,260
Total public	7,727	19,801	7,827	13,710	11,358	11,038	71,461	468,404	585,116	8,906
Federal gov't (included in above classifications)	4,023	7,383	2,511	5,920	1,351	5,628	26,816	137,694	210,468	.....
Private										
Bridges, private	17	1,258	.....	90	1,058	.....	2,423	7,856	6,712	25
Buildings, industrial	842	2,037	5,165	9,251	948	631	18,874	91,166	47,547	611
Buildings, commercial	1,016	8,182	1,358	561	262	280	11,659	50,862	48,554	785
Unclassified, private	2,632	625	432	944	1,093	18	5,744	38,983	25,045	395
Total private	4,507	12,102	6,955	10,846	3,361	929	38,700	188,867	127,858	1,816
June, 1935 (4 weeks)	**12,234**	**31,903**	**14,782**	**24,556**	**14,719**	**11,967**	**110,161**	.....	.....	**10,722**
May, 1935 (5 weeks)	6,284	26,990	13,382	44,833	17,803	13,535	122,827	.....	.....	7,050
June, 1934 (4 weeks)	12,058	17,179	12,199	24,592	14,412	29,553	109,993	.....	.....	2,399
Six months, 1935	46,375	161,909	109,986	137,905	112,078	89,018	.....	657,271	.....	33,751
Six months, 1934	51,950	127,473	141,289	123,636	165,301	103,325	.....	.....	712,974	22,157

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.—WEEKLY AVERAGES

□---1934 ■—1935



New capital

State and municipal bond sales for May total $25,990,000 compared with $19,438,000 for the same period last year. The total for the 6 months is $197,590,000 compared with $148,515,000 a year ago. The PWA withdrew $3,004,000 from allotments outstanding, decreasing the total federal financing by this amount. From the new fund, allotments totalling $520,797,000 were approved by the President, but were statutary allotments required by the Relief Works Act.

Building permits

The total value of permits taken out in May for the 215 cities regularly reporting to Dun & Bradstreet, Inc., was $49,322,110, compared with $51,717,570 in April. This was a decrease of 4.6 per cent, whereas the usual change for the period is a decline of about 6.5 per cent. Comparison with May, 1934, however, when permits totalled $43,825,268, shows a rise of 12.5 per cent. Although not as high as the gains reported in recently preceding months, this marks the fifth consecutive monthly increase over the corresponding period of last year.

Also, the estimated cost of contemplated building operations in May, which includes new work, alterations, additions and repairs, was the highest, with the exception of April, since November, 1931.

The Bureau of Labor Statistics reports a gain of 1.9 per cent in May over April in total building construction including alterations and repairs reported for 773 identical cities. According to these reports there was a 6.2 per cent drop in new nonresidential construction and a 9.3 gain in new residential building permits.

Materials

Cement—Shipments of Portland cement in May totalled 7,428,000 bbl., a decrease of 15.4 per cent from May, 1934, as reported by the Bureau of Mines. The ratio of production to capacity was 36.1 in May, 1935, compared with 37.5 in 1934 and 27.9 in April, 1935. For the 12 months ending May, 1935, the average ratio was 27.7 a one-point gain over the 12-months average ending May, 1934.

Steel—The operating rate of steel companies having 98.7 per cent of the steel capacity of the industry as reported by American Iron and Steel Institute was 39.5, 39.0, 38.3 and 37.7 per cent of capacity for successive weeks of June compared with 57.4, 56.9, 56.1, and 44.7 per cent one year ago.

The American Institute of Steel Construction reports the average operating rate for fabricating to be 35.5 per cent of capacity during May, based on reports from plants owning 77 per cent of the capacity of the whole industry. May bookings were 25 per cent less than the bookings during the same month last year and 27 per cent less than the average monthly bookings during the first quarter of this year. May shipments were 20 per cent less than last year but about 1 per cent larger than average monthly shipments during the first quarter of the current year. The backlog of the industry is approximately 32 per cent less than last year.

Lumber — Although the lumber movement during the last week of May continued low for the fourth consecutive week, production and shipments were slightly above those of the preceding week, according to reports to the National Lumber Manufacturers Association. During the first week of June, 60 fewer mills reported than during the preceding week, yet lumber production was 7 per cent heavier. Shipments from the mills were 10 per cent less and new business was down 21 per cent. Total production showed little change from that of the corresponding week of 1934. Production reported by 953 mills for the last week of May was 131,665,000 ft., shipments, 159,575,000 ft., orders received, 186,393,000 ft.

Prices

Lumber prices dropped in Boston, but increased in Baltimore, Birmingham, Kansas City, St. Louis, San Francisco and Seattle. New York lumber prices held steady over the first of the month but on account of the West Coast strike dealers look for price increases in July on West Coast material, fir, hemlock, red cedar and redwood.

Several minor increases are reported in cement prices, notably at Baltimore, 3c., Cincinnati, 3c., Denver, Detroit and Pittsburgh, 1c., while Chicago reports a 10c. drop and Seattle a 14c. increase.

Structural clay building tile prices show an increase in Baltimore and decreases in Birmingham, Boston, Philadelphia, and Pittsburgh.

Labor

Employment in the production of six major construction materials increased in May to 43.1 on the unadjusted index from 41.2 in April but compares with 44.1 in May last year according to the report of Federal Employment Stabilization Office. According to Bureau of Labor Statistics, employment increased 11 per cent and payrolls, 12.1 per cent in April compared with March on construction not financed from Public Works Administration funds. This gain is reported by 10,395 firms engaged on public projects not financed from PWA funds.

On PWA construction projects an increase of more than 50,000 is reported in the number of wage earners employed at the site. This brought the total for April up to 333,045.

In New York State employment, payrolls and hours for the construction industry continued upward in April. Gains reported by the Division of Statistics and Information, Department of Labor, amounted to 19 per cent in employment, 12 per cent in payrolls and 13 per cent in hours. Highway contractors reported the greatest gain in employment, 91 per cent, with other increases reported: 19 per cent for miscellaneous general contracting, 15 per cent for building contracting and 8 per cent for sub contracting. In New York State in May employment advanced 11 per cent, payrolls 14 per cent, and man-hours 19 per cent.

Labor controversies reported this week are mostly of a minor nature. The differences between the American Federation of Labor and the Progressive Workers of America as to which should supply workers on the new high bridge under construction near Maryville, Ill., were settled when the American Federation of Labor, which holds the contract with the contractor, was given the right to supply the workers, and members of the Progressive Workers of America were given a chance to join the former and be eligible for employment on this particular bridge.

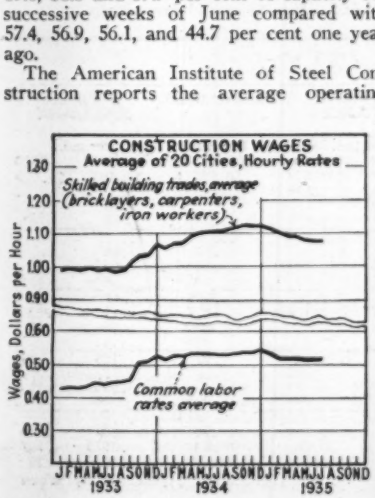
In Washington, a compromise settlement is reported between the contractor and bricklayers on a construction job at Quantico Marine Base. According to report, the bricklayers were employed at $1.10 an hour, but claimed the prevailing-wage rate at Quantico was $1.75 an hour. An agreement on a rate of $1.50 an hour was reached.

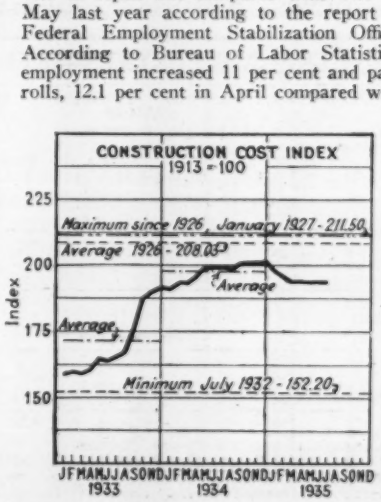
ENR Cost and Volume Index

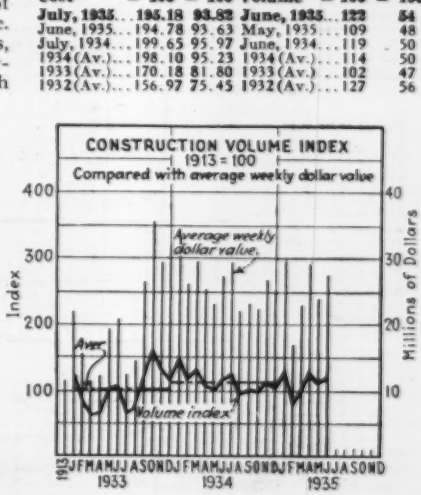
THE *Engineering News-Record* Construction Cost Index is 195.18 for July, a slight increase over the June value, due to a slight rise in the common labor wage average. The *ENR* Volume Index for June is 122 compared with 109 a month ago and 119 last year.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
July, 1935	**195.18**	**93.82**	**June, 1935**	**122**	**54**
June, 1935	194.78	93.63	May, 1935	109	48
July, 1934	199.65	95.97	June, 1934	119	50
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56




CONSTRUCTION COST INDEX
1913 = 100
Maximum since 1926, January 1927 - 211.50
Average 1926 - 208.03
Average
Average
Minimum, July 1932 - 152.20
Index
225
200
175
150
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT — Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included			SAND AND GRAVEL — Per ton, carload lots			CRUSHED STONE — Per ton, carload lots		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE — Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8.25
Baltimore	2.69	2.44	2.24	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	2.25	2.25	7.35
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.45
Boston	2.72	2.47	2.27	1.50	1.53	1.10	1.53	1.50	.....	.....	7.00
Chicago	2.85‡	2.60‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	.....	.....	.....
Cincinnati	2.60	2.35	2.15	1.20	1.20	1.10	1.80	1.80	.....	.....	6.70
Cleveland	2.45	2.20	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	7.75
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	2.10	2.25	.....	.....	7.00
Denver	3.09	2.84	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.26	2.01	1.81	1.30	1.30	1.20	1.4)	1.6)	1.40‡	1.50‡	6.75
Kansas City	2.50	2.25	2.05	.....	1.85	1.15	1.85	1.40-1.55	.....	.....	7.65
Los Angeles	2.70	2.42	.....	1.60	1.60	1.20	1.60	1.60	.....	.....	6.70‡
Minneapolis	2.90	.....	2.45	1.00p	1.00p	.25p	1.00p	1.00 p	.....	.....	6.00
Montreal	.....	1.70	.....	.85	.90	1.25	1.25	1.69	.....	.....	6.00
New Orleans	2.40	2.22	2.00	1.75	1.75	1.45	.....	.....	.....	.....	8.25
New York	2.60‡	2.35‡	.....	1.30†'	1.30†'	.85†'	1.75†'	1.85†'	.....	.....	7.60
Philadelphia	2.63	2.38	2.18	1.80‡	1.90‡	1.50‡	2.60‡	2.75‡	1.00‡	1.00‡	7.75
Pittsburgh	2.46	2.21	1.61	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.00‡	1.00‡	1.00	.75p	.75p	.65/.95§A	.50/.95§B	6.65
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	3.09	2.84	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	7.56

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. A Above 5/16" size, B 5/16" and below—new code sizes. 'Barge lots alongside dock. pf.o.b. plant. '5 tons or more.

CURRENT MAXIMUM NET PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.50	$1.45	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.70	1.65	Iola, Kans	1.70	1.65	Richard City, Tenn	2.00	1.95
Crestmore, Calif	1.72	....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION—SCORED — Per M, lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING—SCORED — Per M, lots of 2,000 pieces or over,			BRICK — Per M, in quantity,		LIME — Per ton,	in paper,	carload lot,
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25	$24.00	$17.00	$15.90
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	17.00	11.50	19.25
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	22.50	3.00§	1.75§	2.25§*
Boston	72.50s	77.45s	145.35s	164.50s	293.70s	.....	14.50	18.00	18.00	12.60	3.10g*
Chicago	66.00	70.40	132.00	.....	.....	.....	10.20	11.20	18.00	13.40	14.00
Cincinnati	70.45	74.95	140.50	168.65	210.00	260.00	17.50	17.50	15.97	12.48	.....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	16.50	16.50	17.20k	14.40k	2.65kp
Dallas	72.00	75.00	197.00	177.00	217.00	269.00	13.50	26.00	21.20	14.50	1.70 p
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00-15.50	21.00-30.00	25.00	17.00	20.00
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	11.50	12.50	14.25	11.90	22.00
Kansas City	72.50	75.50	92.00*	140.50	177.75	207.25	15.00	24.00	15.00	11.25	14.00*
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	79.10s	90.40	169.50s	.....	212.40	136.60	20.75	31.00	23.00	11.00	.....
New Orleans	61.60	65.10	123.20	158.90	196.70	.....	14.00	.....	16.75	13.05	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	10.50	.....	20.80	16.00	20.80
Philadelphia	76.00	80.00	150.00	172.00	240.00	295.00	18.00	20.00	16.35	11.25	10.75
Pittsburgh	58.40c	62.30c	116.85c	165.00c	217.00c	250.00c	17.50	22.00	17.20	14.50	2.22p
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.80p
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	22.50	21.50	2.05p
Seattle	86.00	94.50	210.00	198.00	198.00	198.00	15.00'	18.50	30.00	26.00	3.00p

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. pPer bbl. 180 lbs. gper bbl. 280-lb. kLCL. 'less $1 cash 15 days. slump. ;Smooth. x Selected common.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS — Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M, 3x8½x4 in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	PAVING ASPHALT — Per ton, less than 80 penetration, Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, Tank car	Drums	CUTBACK ASPHALT — Per ton, Tank car	Drums	ROAD OILS — Per gal., Tank car	ASPHALT EMULSION — Per gal., Tank car	Drum
Atlanta	$ 80.00	$35.00	$2.25	$17.40s	$22.57s	$0.0644s	$0.911s	$15.90s	$23.82s	$0.0586s	$0.105	$0.105
Baltimore	110.00	44.00	2.35	17.00	22.00	.07	.095	.085†	.12†	.....	.....	.....
Birmingham	110.00	24.00	....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	100.00	30.00	2.50	16.00	21.00	16.5c#	21.50#	.09†	.12†	.075	.09	.125
Chicago	125.00	42.00	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	115.00	37.00	....	18.00	22.00	.09	.....	18.50	.....	.07	.08	.....
Cleveland	100.00‡	32.75	2.85	20.00	24.50	.075	.09	.075†	.049†	.06	.085	.10
Dallas	.....	30.00	....	16.10	21.10	.0525	.10	15.65	23.15	.055	.1076	.1438
Detroit	.....	37.00	.....	19.67s	24.87s	.....	.....	17.00	22.50	.055	.11	.15
Kansas City	.....	45.00	....	18.50	23.50	17.50#	22.50#	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	.....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	70.00	100.00	....	14.00	19.66	.07	.093	19.00	26.50	.07	.125	.155
New Orleans	100.00	32.00	....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	130.00§	50.00	2.64	17.00	22.00	.07	.095	.085†	.12†	.....	.075	.11
Philadelphia	122.00	45.00	2.25	13.50	18.00	.05	.03	.05†	.08†	.045	.08	.....
Pittsburgh	115.00	40.00	....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115.00	35.00	2.00	19.20	24.70	.075	.075	.875†	11.75†	.04	.09	.125
San Francisco	.....	50.00	....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	55.00	....	25.50	25.50	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in. #Per ton §4x5x9-in. Av. sMexican. 5local reduction due to 20% reduction intra-state class freight rates, only Georgia affected.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS	RIVETS	WIRE NAILS	SHEET PILING	STEEL RAILS (Per Gross Ton)			TRACK SUPPLIES			
						Standard	Light	Re-rolled	Angle bars	Std. spikes	Tie plates	Track bolts
		¾-in. billet,	½-in. structural	Base	Base							
Birmingham	$1.95	$2.10	.....	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.80	2.05	2.90	$2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—BASE MILL PRICES, PER 100 LB., CARLOAD LOTS

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price		EXPANDED METAL LATH —Per 100 sq.yd., carload lots—		WELDED FABRIC REINFORCING —Per 100 s.f., carload lots—		6x6 in., No. 6 & 6 wires Per sq.yd	SHEET PILING Per 100 lb., base price
		New billet	Rail steel	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires		
Atlanta	$3.36	$2.34	$2.19	$21.00	$23.00	$1.53	$1.16	$0.1449	$2.70
Baltimore	3.00	2.75	2.60	25.00	28.00	1.41	1.08	.1332	2.90
Boston	3.54	3.18	2.25	22.00†	24.00†	1.46	1.12	.1449	2.30
Chicago	3.20	2.10	1.95	22.00	26.00	1.40	1.08	.1323	2.25
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	.....
Cleveland	3.16	2.60	2.45	20.00	22.00	1.37	1.06	.1287	.....
Dallas	3.25	2.80	2.65	22.00	25.00	1.63	1.23	.1548	2.985
Denver	3.89	3.67	3.52	22.00	25.00	1.68	1.26	.1548	.....
Detroit	3.17	2.20	2.05	20.00†	22.00†	1.41	1.08	.1323	2.43
Kansas City	3.74	2.74	2.59	19.00	21.00	1.50	1.14	.1422	2.69
Los Angeles	3.10	2.95	.....	23.00	27.50	1.68	1.26	.1584	2.65
Minneapolis	3.45	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.55§
Montreal	2.90	3.00	2.80	.....	.....	2.30	1.71	.238	2.65
New Orleans	.....	.....	.....	19.15	23.00	1.54	1.17	.1458	.....
New York	3.37	2.86	2.71	20.00	22.00	1.44	1.11	.1359	2.48
Philadelphia	2.98	3.06	2.22	20.00	24.00	1.42	1.09	.1332	2.46
Pittsburgh	1.80‡	1.80‡	1.70‡	20.00‡	22.00‡	1.34	1.04	.1260	2.15
St. Louis	3.45	2.95	2.80	22.00	24.00	1.42	1.09	.1341	2.25
San Francisco	3.55	2.475	2.325	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.50	2.50	.....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots	WHITE LEAD Per 100 lb. in 500-lb. lots#	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots, f.o.b. factory				
	Dry	in oil	Graphite*	Aluminum†	Ferric Oxide‡	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$10.50	$1.60	$3.10	.....	$1.81	$1.97	$2.90	.36	$25.40
Baltimore	7.00	10.00	1.40	2.25	$1.90	2.35	2.55	2.55	.48	25.00
Birmingham	7.25	10.50	2.35	2.35	1.85	2.20	1.79	.....	.36	23.00
Boston	7.00	10.00	1.85	2.75	.04½x	1.90	2.90	2.90	.42	20.00
Chicago	7.00	10.00	1.85	2.45	1.30	1.60	1.59e	1.59e	.24	20.00
Cincinnati	7.00	10.00	1.45	2.50	1.40	2.40	2.39e	2.39e	.36	21.00
Cleveland	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79e	.24	22.00
Dallas	7.25	11.00	1.80	2.24	.....	2.90g	4.17	4.17	.15	35.00
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	.60	30.00
Detroit	7.00	10.00	1.45	2.20	1.30	2.55	2.80	2.80	.37	30.00
Kansas City	7.00	10.12½	1.25	2.25	1.00	2.05	3.10–3.20	3.10–3.20	.23	26.50
Los Angeles	7.25	10.25	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.12½	.....	.....	.....	1.60	1.79e	1.79e	.29	25.30
Montreal	.....	8.20	1.70	3.45	1.65	2.00	2.62	2.07	1.40§	1.52§
New York	7.00	10.00	1.60	2.00	1.40	1.60	1.79e	1.79e	.232	22.00
Philadelphia	7.00	10.00	2.50	2.95	1.50	1.68	1.86e	1.48e	.37	22.00
Pittsburgh	7.00	10.00	1.05	1.95	.80	1.75	1.65e	1.65	.38	25.00
St. Louis	10.00	10.00	1.85	2.45	1.30	1.87e	3.22	3.22	.28	20.00
San Francisco	7.25	10.25	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	10.25	1.80	2.85	2.20	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. eRoll. 65 lb. xPer lb. g500-lb. drums.
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928

	Single or Double Thickness	
	A quality	B quality
Atlanta	85%	85%
Baltimore	88–10%	90–10%
Birmingham	88%	90%
Boston	88–10–5%	90–10–5%
Chicago	90%	92%
Cincinnati	89–10%	91–10%
Cleveland	89-10%	91-10%
Dallas	86%	88%
Denver	84%	86%
Detroit	87–10%	89–10%
Kansas City	87–10%	88–10%
Los Angeles	90%*	90–40%
Minneapolis	85%	87%
Montreal	.....	.....
New Orleans	88%	90%
New York	88%	90%
Philadelphia	89%	91%
Pittsburgh	88%	88%
St. Louis	90%	92%
San Francisco	82%	87%
Seattle	90–10%	90–20%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin	
	40%	60%
Atlanta	$0.155	$0.17
Baltimore	.16	.175
Birmingham	.105	.120
Boston	.17	.1725
Chicago	.....	.....
Cincinnati	.27	.29
Cleveland	.19	.205
Dallas	.17	.185
Denver	.155	.17
Detroit	.237	.255
Kansas City	.16	.175
Los Angeles	.1725†	.1925†
Minneapolis	.17	.185
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.225	.24
Philadelphia	.1550	.17
Pittsburgh	.11	.1250
St. Louis	.135	.15
San Francisco	.1572	.1775
Seattle	.1425	.1575

‡Double thickness A & B

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90@$2.15
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalised with points of competition, per ton	22.00@35.00
Chlorine cylinders, per lb. delivered	.05½
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb.	1.20
Sulphate of aluminum, commercial, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb.	3.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf—Barge	Short Leaf—Rail	Long Leaf—Barge	Long Leaf—Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.12	$0.165	$0.13	$0.16
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.16	.21	.15	.20
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.17	.225	.16	.21½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.195	.235	.20½	.24½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2125	.245	.24½	.30½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.275	.385	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.315	.452	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.20	$1.75
	Pine, untreated	1.25	1.75
	Pine, creosoted	1.70	2.40
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	no market	
	Southern pine, untreated *4x6x8'6"	.45*	.60
	Southern pine, creosoted	1.00*	1.20
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.00	.....
	Red oak, creosoted	.....	2.10
St. Louis	White oak, untreated	1.03	1.35
	Red oak, untreated	.95	1.30
	Red oak, creosoted	1.40	1.90
	Sap Pine or cypress, untreated	.80	1.20
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.10
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, standard (‡ f.o.b.) 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-24 12 in.	24 in.	Full standard weight, # 1 to 3 in., Butt Weld Black	Galv.	3½ to 6 in., Lap Weld Black	Galv.
Atlanta	$43.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	44%	37%	42%	34%
Baltimore	46.50	.25	.50	2.10	5.75	106.00	166.50	.75	2.00				
Birmingham	39.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	46.50	.196	.378	1.72	5.06	51.10	85.85	.378	2.15				
Chicago	47.50	.285	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	46%
Cincinnati	46.00	.203	.3915	1.665	5.125	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.245%
Cleveland	47.50	.196	.378	1.62	5.0225	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	51.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	53%	64%	56%
Denver	59.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	56%	45%	43%‡	57%‡
Detroit	47.50	.245	.4725	2.025	5.74	82.00	136.60	.35	1.20	48.6%	38.2%	47.3%	37.6%
Kansas City	49.00	.32	.57	2.27	4.90	120.00	240.00	.40	1.50	56%	47%	57%	48%
Los Angeles	47.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	49.50	.255	.459	1.836	4.67	.....	.....	.50	1.34	.....	.....	.....	.....
Montreal	55.00	.80	1.50	6.00	.....	45.00	90.00	.45	.....	.....	.....	.....	.....
New Orleans	45.00	.32	.51	1.65	.....	67.00	.....	.45	2.00				
New York	46.00	.26	.51	2.25	6.75			.55	2.00	51.88%*	40.86%*	53.10%*	42.08%*
Philadelphia	43.00	.336	.648	2.835	8.68	175.00	210.00	.54	1.83	52.37%*	41.35%*	53.39%*	42.57%*
Pittsburgh	49.00	.175‡	.3375‡	1.44‡	4.81‡	69.00	108.00	.75	1.75	64%	55%	65%	56%
St. Louis	46.00	.55	.459	1.836	3.96	85.00	170.00	.80	2.00	51.266%	40.245%	52.49%	41.47%
San Francisco	47.00	.765	.477	1.908	5.22	103.50	172.50	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	48.50	.35†	.63†	2.52†	6.30†	96.00	200.00†	.50†	1.80	60%	50%	65%	50%

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional. 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less. ‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8¢; ⅜ in. 11¢.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

‡2½ to 3 in. *Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.	
		All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.									Merchantable grade up to 20 ft.	
		1x6,S	1x8,S	2x4,S	2x6,S	2x8,S	2x10,S	3x12,R	6x12,R	12x12,R	2x12,R	12x12,R
Atlanta	Southern Pine	$16.00	$16.00	$18.00	$18.50	$21.00	$19.50	$28.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	20.50	24.00	29.50	28.50	29.00	30.50	37.60			54.00	55.00
	Douglas Fir	29.50	29.00	31.00	29.00	30.00	30.50	32.00	$33.00	$34.00		
Birmingham	Long Leaf	17.00	17.25	17.25	15.25	16.25	16.25	38.00			33.00	35.80
	Southern Pine	17.00	17.25	16.00	14.00	15.00	15.00	25.00	25.00	24.00	.....	.....
Boston	Southern Pine	28.00	28.00	35.00†	37.00†	51.00‡	60.00‡	73.00‡	.....	.....	73.00	73.00
	Douglas Fir	28.00	28.00	35.00	35.00	35.00	37.00	40.00	43.00	43.00	.....	.....
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.50	45.00	.....	.....	54.00	58.00
	Douglas Fir	28.50	29.50	31.75	30.50	30.50	28.50	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	24.00	25.00	26.00	25.00	25.50	26.50	40.00	.....	.....	31.50	.....
	Douglas Fir							43.50	46.25	46.25		
Cleveland	Southern Pine	26.00	28.00	32.00	28.00	31.00	32.00	45.00	43.00	.....	48.00	58.00§
Dallas	Southern Pine	d28.35	30.60	31.50	29.80	30.15	30.15	50.40	.....	.....	42.75	67.95
Denver	Douglas Fir	40.00	41.00*=	43.00*	43.00*	43.00*	45.00*	49.00*	55.00*	61.50	.....	.....
Detroit	Southern Pine	24.00	24.00	25.00	24.50	24.50	25.50	35.00	.....	.....	29.00	41.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	41.50	41.50	41.50	.....	.....
Kansas City	Southern Pine	24.50	25.50	24.50	24.50	24.50	26.50	37.00	.....	.....	54.50	60.50
	Douglas Fir	24.50	27.75	26.75	26.75	26.75	28.50	37.00	37.00	37.00	.....	.....
Los Angeles	Douglas Fir	24.00y	25.50y	26.00y	26.00y	26.00y	26.00y	38.00y	30.00y	34.00y	.....	.....
Minneapolis c	Western Pine	45.00*	51.50*	53.00*	41.00*	41.00*	42.00*	59.50*x	.....	.....	53.00*x	.....
	Douglas Fir	39.00*	42.00*	43.50*	41.00*	41.00*	42.00*	59.50*	59.50*	59.50*	.....	.....
Montreal	Spruce	30.00	31.00	27.00	29.00	32.50	35.00	38.00			.....	.....
	Douglas Fir	47.50	53.00	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	24.05	26.00	30.00	26.00	27.00	27.00	39.00	.....	.....	45.00	55.00
	Douglas Fir	28.95	31.50	33.90	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	34.00*	35.00*	34.00*	35.00*	36.00*	37.00*	45.00*			70.00*	70.00*
	Douglas Fir	.....	.....	38.00*	38.00*	38.00*	39.00*	38.00*	42.00*	42.00*	.....	.....
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00	.....	.....	36.00	42.00
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00	42.00	.....	.....
Pittsburgh	Southern Pine	30.50	31.90	37.65	33.75	36.52	37.50	47.75	.....	.....	57.50	57.50
	Douglas Fir	38.52	39.70	39.70	38.55	39.10	39.38	53.25	53.25	53.25	.....	.....
St. Louis	Southern Pine	29.00*x	30.00*x	30.00*x	29.00*x	29.50*x	30.00*x	50.00*x	.....	.....	65.00*x	65.00*x
	Douglas Fir	.....	.....	.....	.....	.....	.....	55.00*x	55.00*x	55.00*x	71.00	69.00
San Francisco	Douglas Fir	23.00f*	20.00f	21.50f	21.50f	22.50f	22.50f	24.50	25.00f	25.00f	.....	.....
Seattle	Douglas Fir	14.00	15.00	15.00	14.00	14.00	14.00	20.00	19.00	19.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. =Native. fAt ship's tackle. yYard prices. d10% Disc. taken off. x5M ft. or less 8S4S. RRgh. cContractors in Minneapolis and St. Paul get 20% disc. from list.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.50/.70	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.90/1.375	.45	.45
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.25	1.25	.72	.72
Dallas	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.55/.60	.55/.75
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.25	1.25	1.25	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.82½	.50/.82½
Philadelphia	.35/1.50	.65/1.10	.70/1.375	.90/1.00	1.10/1.37	.35/50	.40/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.37½	1.50	.78¾	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	1.00	1.00	1.25	1.25	1.25	.60	.60
Montreal	1.00	1.00	1.25	1.25	1.25	.60	.60

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.0797 Common Avg. $0.5289 *6-hr. Day. † PWA.